Social cognition and facial emotion processing in patients with focal frontal lobe damage

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CONTENTS

Part I

Systematic Literature Review

A SYSTEMATIC REVIEW OF THE CHANGES IN BASIC EMOTION RECOGNITION AND SOCIAL COGNITION IN PATIENTS WITH FRONTAL LOBE DAMAGE

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1. Abstract

This review aims to evaluate the empirical literature relating to the affect recognition and social cognition of patients who have lesions to areas of the frontal lobes of the brain. Following a thorough search, 39 papers were included in this systematic review. The majority of these papers reveal that most patients with lesions in the orbitofrontal and ventromedial areas of the frontal lobe have difficulties recognising emotion from faces or prosody, as well as impairments in some aspects of social cognition ("hot" social cognition: e.g. reduced cognitive and affective empathy, significant difficulties with processing of complex social emotions such as guilt). Impairments in theory of mind (or "cold" social cognition skills) are also widely reported in patients with damage to the ventromedial and dorsolateral prefrontal cortex. This pattern of impairment is not only present in patients with focal damage (e.g. stroke, tumours, surgical lesions, some forms of TBI) but also in patients with diffuse damage to the frontal areas such as MS probably due to with lesions of fibre tracts in the white matter interconnecting cortical regions related to emotion processing and social cognition. The relationship between basic emotion recognition and social cognition is also discussed in the light of these findings, and recommendations are made for the neuro-rehabilitation of patients who have damage to the frontal lobes.

2. Introduction

Damage to the frontal lobes of the brain usually leads to neuropsychological, behavioural and emotional deficits which may affect, among other things, the individual's ability to function effectively a social environment. Emotional and cognitive skills are necessary to understand others' mental states, predict their intentions and behaviours and to respond adequately to various social exchanges. Consequently, these emotional and cognitive skills are essential for successful functioning.

Most patients who have damage to areas of the frontal lobes experience behaviour and personality changes. This may include increased risk-taking behaviour (e.g. Bechara, Damasio, Damasio et al.,1994), impulsiveness (Winstanley, Theobald, Cardinal and Robins, 2004), antisocial personality traits (Meyer, Berman, Scheibel and Hayman, 1992), poor socio-moral judgment (e.g. Blair and Cipolotti, 2000) and difficulties in maintaining interpersonal relationships (e.g. Blais and Boisvert, 2005). Most of those deficits have been linked in the past to impairments in executive functioning. For example, it has been proposed that poor decision making, self-monitoring and self-regulating behaviours lead to breakdowns in social relationships (e.g. Tanji, Shima and Mushitake, 2007; Ganesalingam, Sanson, Anderson and Yeates, 2007). However, several researchers have also suggested that a wide range of interpersonal difficulties can occur in this patient population in the absence of clear executive difficulties (e.g. Cicerone and Tanenbaum, 1997; Blair and Cipolotti, 2000; Tranel, Bechara and Denburg, 2002; Stuss, 2011). In addition to their role in executive functioning, the frontal lobes also have important roles in emotional recognition (e.g. Kucharska-Pietura, Phillips, Gernand et al, 2003; Hornak, Bramham, Rolls, Morris et al, 2003). Emotion recognition is the ability to accurately recognise the emotion being expressed, either through a person's facial expression or vocalisations.

Successful social exchanges are based on the ability to accurately perceive and interpret social cues such as emotional expressions (facial, vocal or general body language), as well as correctly infer others' perspectives, intents, beliefs, emotional states (social cognition). The purpose of this review is to

systematically examine the literature regarding how damage to the frontal lobes affects an individual's emotion recognition and social cognition abilities.

Cross cultural research on the expression and recognition of facial emotion showed that there are six “basic” emotions which are universal: anger, disgust, fear, happiness, sadness and surprise (e.g. Ekman, Sorenson and Friesen, 1969; Izard 1968; 1971). There is considerable evidence showing that in non-clinical populations happiness is recognised with far greater accuracy (87-97%) than negative emotions, particularly fear (68-88%; Ekman et al., 1969). It has been suggested that this is due to there being only one clearly defined positive emotion (happiness) whereas there are four or five different negative emotions (e.g. Calvo and Lundqvist, 2008). Consequently, people may get confused between negative emotions and mislabel them, whereas they are less likely to confuse happiness with one of the negative emotions. This performance bias is relevant when discussing the findings on clinical populations.

Social cognition is an umbrella term for several cognitive skills that allow one to form a representation of another's mental states (e.g., beliefs, emotions and intentions). Several authors distinguish between "hot" (mainly emotion based) and "cold" (mainly cognitive based) social cognition. "Hot social cognition" comprises the abilities to accurately detect a wide range of emotions in others (e.g., basic emotions and more complex emotions such as jealousy) and empathising with them (e.g., experiencing a similar emotion in the absence of the original stimulation, triggered solely by the perceived emotion in others). "Cold social cognition" refers to the ability think from another person's perspective (also known as forming a Theory of Mind - ToM; Frith and Frith, 2010). Hot and cold social cognitions form the basis of understanding others' mental states and help predict their actions, which together with knowledge of social and moral norms help adjust own behaviours towards others in an appropriate way. Since social cognition is a complex concept with multiple components (which are assessed separately using a wide range of instruments), no clear pattern of functioning is consistently reported in non-clinical populations. However, clear differences between clinical and non-clinical populations are often reported (e.g. Stone, Baron-Cohen and Knight, 1998).

There have been a small number of reviews looking at either emotion recognition or social cognition (or both) in people with traumatic brain injury. However, those where not systematic reviews and have a number of limitations.

For example, Radice-Neumann, Zupan, Babbage and Willer (2007) reviewed several papers reporting on basic facial emotion recognition in patients with traumatic brain injury (TBI) and concluded that impaired facial affect recognition appears to be a ubiquitous consequence of frontal brain damage in most individuals with TBI. Notably, social cognition was not explicitly addressed. It is also unclear whether this was an exhaustive review of the literature or just an illustrative sample which was sufficient to enable the authors to propose that rehabilitation strategies should include emotion retraining.

Another recent review (Mc Donald, 2013) focused on the literature reporting mainly changes in social cognition following traumatic brain injury (TBI), although changes in facial and vocal emotion perception are also briefly covered. The author concluded that, despite small heterogeneous samples presented, there is convincing evidence that impairments in social cognition and basic emotion recognition are fairly frequent in individuals with TBI. Similar to Radice-Neumann et al, (2007) this review is not a systematic review, and therefore it is difficult to assess the quality of studies reviewed, or whether it covers all the available literature. The lack of a systematic overview of the tasks used in to assess social cognition and emotion recognition in the reviewed papers makes the interpretation of results difficult. Additionally, the review is focused solely on papers presenting TBI samples and does not include other types of brain lesions that may produce a similar pattern of impairment. Other reviews (e.g., Ochsner et al., 2012) have focused on fMRI literature which investigated brain mechanisms underlying emotion regulation. They discuss fMRI data relating to emotional regulation but do not review lesion studies.

Despite an increasing number of studies published since 1998 reporting changes in emotion recognition in patients with frontal brain injury, a considerable number of studies discussing rehabilitation interventions after frontal lobe damage, do not discuss emotion perception/complex emotional inference retraining. For example, the most recent review (Hunt, Turner, Polatajko, Bottari & Dawson, 2013) focused on understanding the relationship

between executive function, self-regulation and attribution in relation to goal-directed behaviour in adults. This is consistent with the idea that most of the deficits seen in patients with frontal injury are linked to impairments in executive functioning, and thus emotional recognition or complex social cognition have not been covered despite a plethora of studies which reported changes in these cognitive domains.

In conclusion, there appears to be no systematic review of the literature looking specifically at changes in emotional perception and social cognition in patients with a wide range of frontal lobe lesions (e.g. TBI, stroke, surgery, etc). Thus, by reviewing the frontal lobe lesion literature specifically for studies which looked at changes in emotional perception and social cognition, we aim to bridge the current gap in the literature left by the previous reviews. Secondly, this may also contribute to our understanding of the changes in personality, socio-moral judgments and social interaction in patients with frontal lobe lesions. Finally, this may help inform rehabilitation interventions following frontal lobe lesions.

3. Methods

A systematic search was conducted on Web of Science databases (all databases included) using the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA, Mohr at al., 2009) guidelines to identify relevant studies published prior to 2015.

3. 1. Study eligibility criteria

Experimental studies conducted on adult human participants with frontal brain lesions which investigated facial emotion perception and/or social cognition were included in this systematic review. This included single case studies. However, studies on children and adolescents were not included since developmental issues may induce additional variability to emotion recognition and more importantly on social cognition. Studies describing changes in emotion processing conducted on participants with diagnosed psychiatric conditions were also excluded due to possible confounds for emotion

recognition difficulties. Only research articles presenting empirical studies (e.g. not reviews), peer reviewed and published in the English language were included. Published studies from the year 1980 to 2015 were included in the search since full text articles published before 1980 would have been difficult to obtain in the time frame of this study.

3. 2. Search Strategy

The search terms used were: (Acquired OR Trauma*) AND (Frontal AND (Damage OR Lesion OR Injury) AND ((Emotion* OR Affect* OR (Complex OR Social AND Emotion* OR Affect*) OR (Sad* OR Happ* OR Disgust OR Anger OR Angry OR Fear* OR Surprise)) AND (Perception OR Perceive OR Detection OR Processing OR Recog*).

3. 3. Methodological quality

This review employed the Critical Appraisal Skills Programme (CASP) checklist for case-control studies (presented in the Appendix). CASP contains a list of eleven quality items that are judged to be either present, absent or unclear for each paper assessed. The NICE rating system for methodological quality of studies (NICE, 2007, see Table 1 below) was then used to rate the studies from good quality (when all or most of the CASP criteria have been fulfilled "++"), to reasonable quality (when the most important criteria have been fulfilled "+") and poor quality (when few or no criteria have been fulfilled "−"). Five papers (12.8%) included in this review were randomly selected and rated independently by another researcher who had experience with the literature. The checklist and rating procedure was discussed prior to ratings being made to minimise different interpretations of the checklist items. Inter-rater reliability (IRR) was calculated using Cohen Kappa (Cohen, 1960), and was found to be 0.7 (good reliability). Any disagreements were subsequently resolved through discussion.

++	All or most of the criteria have been fulfilled. Where they have not been fulfilled the conclusions of the study or review are thought very unlikely to alter
+	Some of the criteria have been fulfilled. Those criteria that have not been fulfilled or not adequately described are thought unlikely to alter the conclusions.
-	Few or no criteria fulfilled. The conclusions of the study are thought likely or very likely to alter.

Table 1: Nice (2007) rating system for methodological quality of the studies.

3. 4. Risk of bias across studies

a) Language bias: only articles in English were considered.

b) Database bias: only articles found in English language databases were assessed such as Medline and Web of Science

c) Researcher bias: although the initial search was based on strict inclusion criteria, the initial selection of papers was done by a single author.

d) Study quality and publication bias: only studies published in peer review journals were included in this review. However, it is well known that studies which report significant results are more likely to be published than ones which report non-significant results ("the file drawer problem" Rosenthal, 1979).

4. Results

The search strategy (underlined in section 3.2) returned 197 studies from Web of Science. An additional six studies were identified from references cited in the studies returned by the search. Since there were no duplicates, a total of 203 records were screened and 164 were excluded (see exclusion criteria described in section 3.1). The remaining 39 studies were included in the qualitative synthesis.

PRISMA 2009 Flow Diagram

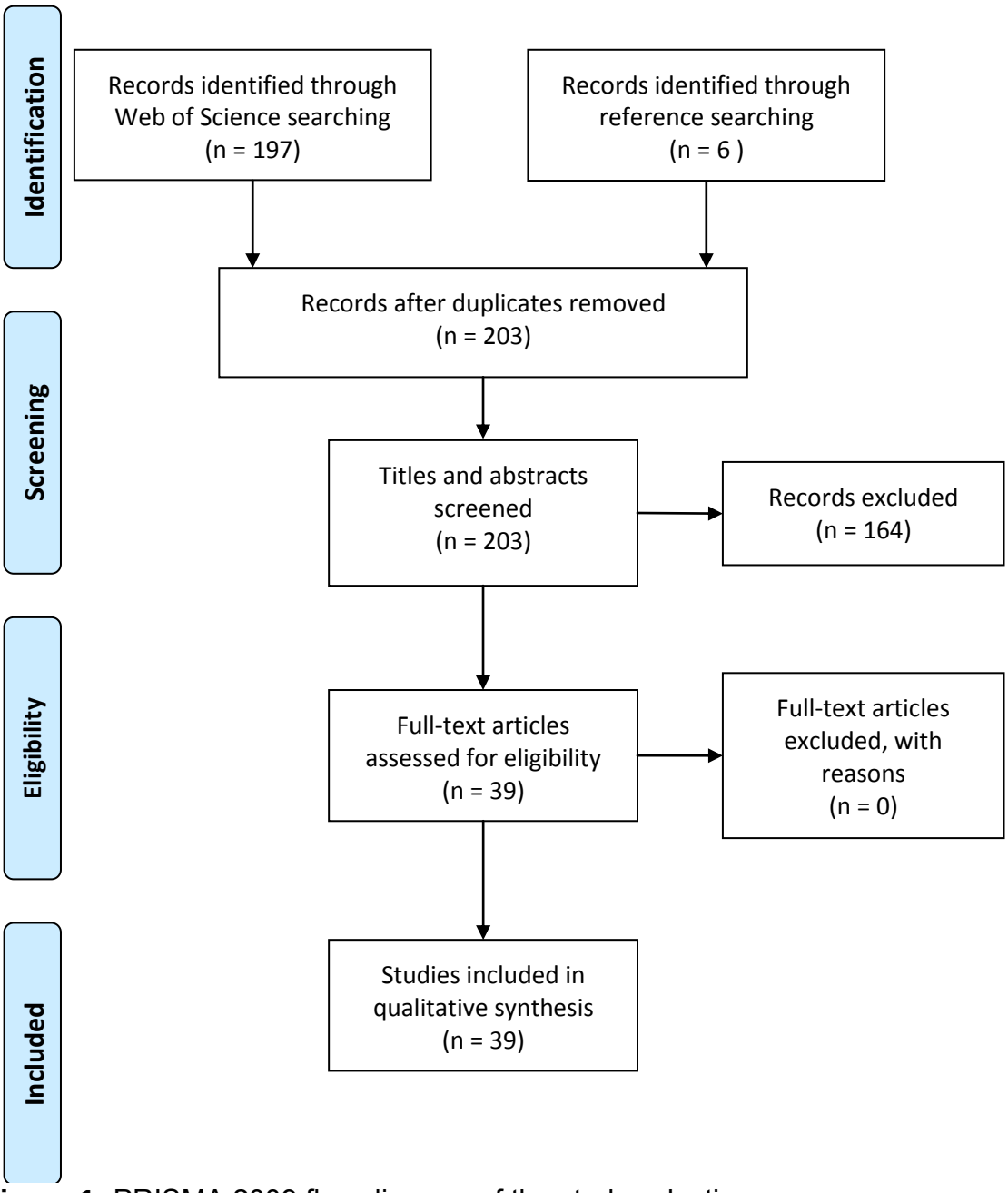

Figure 1: PRISMA 2009 flow diagram of the study selection process.

4. 1. Summary of studies

Table 2 provides an overview of the 39 included papers. For a breakdown of participants' gender and average age, as well as study quality ratings please refer to Table 3 in Appendix One.

Table 2: Summary of studies.

Year	Reference	Title	Paper type	Sample Size (patients / controls)	Social Cognition Tasks	Emotion Recognition /other Tasks	Brain Lesion	Brief Findings
2014	Njomboro, et al.	Exploring social cognition in patients with apathy following acquired brain damage	Controlled	49/56	MST, SAT, TOM: Reality Unknown, TOM: Reality Known (Samson et al, 2004)	FEEST: Ekman 60 FEEST: Hexagon Test	CVA, Frontal TBI, Anoxia, HSE	Patients with frontal damage showed impaired social and moral judgements. There was no difference in emotion recognition between frontal an non frontal lesion groups but both groups performed lower than controls
2013	Spikman, et al.	Deficits in Facial Emotion Recognition Indicate Behavioral Changes and Impaired Self-Awareness after Moderate to Severe Traumatic Brain Injury	Controlled	51/33	N/A	FEEST:Ekman 60	Moderate TBI	Impaired emotion recognition in the patients, and in particular of Sadness and Anger. This correlated with impaired self-awareness.
2013	Mike, et al.	Disconnection Mechanism and Regional Cortical Atrophy Contribute to Impaired Processing of Facial Expressions and Theory of Mind in Multiple Sclerosis: A Structural MRI Study	Controlled	49/24	FP, Reading the Mind in the Eyes Test	Faces Test	MS	Poorer emotion and mental state recognition in patients with MS due to cortical gray matter damages.
2013	Kemp et al.	Caudate nucleus and social cognition: Neuropsychological and SPECT evidence from a patient with focal caudate lesion	Single case	1/12	FP, FASOBT, Reading the Mind in the Eyes Test, MCJ,SAT	Eckman 60	CVA	Impairments in the “hot” social cognition as well as in the ability to recognize negative emotions (i.e., sadness and fear)

Year	Reference	Title	Paper type	Sample Size (patients / controls)	Social Cognition Tasks	Emotion Recognition /other Tasks	Brain Lesion	Brief Findings
2013	Dal Monte et al.	A voxel-based lesion study on facial emotion recognition after penetrating brain injury	Controlled	180/53	N/A	FEEST:Ekman 60	Focal Frontal TBI	Patients with damage to anterior and bilateral PFC lesions had deficits in recognizing unpleasant emotions, whereas damage to posterior and bilateral PFC resulted in impaired recognition of pleasant emotions
2012	Spikman et al.	Social Cognition Impairments in Relation to General Cognitive Deficits, Injury Severity, and Prefrontal Lesions in Traumatic Brain Injury Patients	Controlled	28/33	TOM: Cartoon, FP, Empathy Questionnaire	FEEST:Ekman 60	Prefrontal TBI	Patients performed significantly worse than healthy controls on all measures, with the highest effect size for the emotion recognition test (FEEST)
2012	Neumann et al.	Affect Recognition, Empathy, and Dysosmia After Traumatic Brain Injury	Single Group	106	IRI	DANVA2-AF DANVA2-AP EIST	Moderate to severe frontal TBI	Patients showed affect recognition impairments and reduced empathy.
2012	Martins et al.	Atypical moral judgment following traumatic brain injury	Controlled	29/41	Social Emotion Recognition Task (adapted from Greene et al 2004) Moral Judgement task: 50 dilemmas	N/A	Frontal TBI	Patients showed more utilitarian responses for moral dilemmas when compared to controls and difficulties in social emotion recognition.

Year	Reference	Title	Paper type	Sample Size (patients / controls)	Social Cognition Tasks	Emotion Recognition /other Tasks	Brain Lesion	Brief Findings
2012	Martins et al.	Changes in social emotion recognition following traumatic frontal lobe injury	Controlled	31/41	Social Emotion Recognition Task (adapted from Greene et al 2004)	N/A	Frontal TBI	Recognition of social emotions (arrogance and jealousy) was significantly reduced in patients; patients with bilateral lesions showed a lower accuracy on all social emotions.
2012	Dethier et al.	Spontaneous and posed emotional facial expressions following severe traumatic brain injury	Controlled	23/29	N/A	Facial expressivity task (Dethier et al. 2012)	Prefrontal TBI	Preference for utilitarian responses for moral dilemmas and difficulties in social emotion recognition in TBI patients
2011	Xi, et al.	Contributions of subregions of the prefrontal cortex to the theory of mind and decision making	Controlled	30 (16 VMPC; 14 DLPC) /30	FP	N/A	Prefrontal TBI - Focal Lesions	Patients with prefrontal lesions showed impairments of the theory of mind (FP) but performance on the decision making tasks was unaffected.
2011	Phillips et al.	Specific Impairments of Emotion Perception in Multiple Sclerosis	Controlled	32/33	N/A	FEEST, DEPVT	MS	MS patients were impaired at both static and dynamic emotion recognition tasks.
2011	McDonald et al.	Social dysdecorum following severe traumatic brain injury: Loss of implicit social knowledge or loss of control?	Controlled	22/25	IAT, ASI, ATWS	N/A	Severe TBI, including frontal damage	Patients performed normally on social cognition tasks but showed impairment on executive function tasks

Year	Reference	Title	Paper type	Sample Size (patients / controls)	Social Cognition Tasks	Emotion Recognition /other Tasks	Brain Lesion	Brief Findings
2011	McDonald et al.	Emotion Perception and Alexithymia in People With Severe Traumatic Brain Injury: One Disorder or Two? A Preliminary Investigation	Controlled	20/20	N/A	Ekman 60; TAS -20	Severe chronic TBI	Patients were impaired for matching facial expressions. Their performance on 'fear' was especially poor. They also scored significantly higher on alexithymia scale but there was no association between poor emotion recognition and Alexithymia.
2011	McDonald et al.	Impaired mimicry response to angry faces following severe traumatic brain injury	Controlled	21/20	N/A	Modified Ekman 60	Frontal TBI	Reduced emotion recognition and reactivity to angry expressions in the TBI group.
2011	Callahan et al.	Liberal bias mediates emotion recognition deficits in frontal traumatic brain injury	Controlled	14/22	N/A	Modified Ekman 60	Frontal TBI	Patients showed facial emotion recognition impairment and a liberal bias when rating facial expressions, leading them to associate intense ratings of incorrect emotional labels to sad, disgusted, surprised and fearful facial expressions.
2010	Williams et al.	Impairment in the recognition of emotion across different media following traumatic brain injury	Controlled	64/64	N/A	FEEST:Ekman 60, TASIT/EET	Frontal TBI	Patients were significantly impaired for basic emotion recognition. The difference between the recognition of positive and negative emotions was larger in the patient group.

Year	Reference	Title	Paper type	Sample Size (patients / controls)	Social Cognition Tasks	Emotion Recognition /other Tasks	Brain Lesion	Brief Findings
2010	Geraci et al.	Theory of Mind in patients with ventromedial or dorsolateral prefrontal lesions following traumatic brain injury	Controlled	18 (11 VMPC; 7 DLPC) /20	Reading the Mind in the Eyes Test, FP	N/A	Prefrontal TBI (predominantly focal lesions)	Patients performed significantly lower than controls on Reading the Mind in the Eyes Test. However only patients with lesions in the ventromedial cortex (VMPC) performed poorly on the FP test.
2009	Henry et al.	Evidence for deficits in facial affect recognition and theory of mind in multiple sclerosis	Controlled	27/30	Reading the Mind in the Eyes Test	Ekman 60	MS	MS participants were signifi cantly impaired on the ToM task, and also on the facial emotion recognition tasks especially for anger and fear.
2009	Chiavarino et al.	Frontal and parietal lobe involvement in the processing of pretence and intention	Controlled	7 frontal/10 parietal/14 controls	Pretence task (designed by the authors)	N/A	CVA, Anoxia, HSE	Patients with parietal and frontal damage had more difficulties than controls in understanding the intentional nature of pretence. Patients with parietal lesions patients in particular, had difficulties with the identification of pretend actions.
2007	Koenigs et al.	Damage to the prefrontal cortex increases utilitarian moral judgements	Controlled	6 patients with VMPC damage/ 12 patients with no VMPC damage/ 12 controls	Modified 50 dilemmas Green et al, 2004	N/A	Focal damage to VMPC	Abnormal pattern of judgements on moral dilemmas in patients with focal lesion in VMPC only.

Year	Reference	Title	Paper type	Sample Size (patients / controls)	Social Cognition Tasks	Emotion Recognition /other Tasks	Brain Lesion	Brief Findings
2006	Mitchell et al.	Divergent patterns of aggressive and neurocognitive characteristics in acquired versus developmental psychopathy	Single Case but compared with several controls	1/5	JCT, SAT	Modified Ekman 60; Audio Emotion Recognition	Penetrating frontal TBI (bilateral)	The patient showed no impairment in TOM tasks, but was impaired for emotion recognition tasks and social norms violations.
2006	Henry et al.	Cognitive and psychosocial correlates of alexithymia following traumatic brain injury	Controlled	28/28	N/A	TAS-20	TBI (8 patients had frontal TBI)	Patients had difficulties identifying emotions and showed reduced introspection.
2006	Henry et al.	Theory of mind following traumatic brain injury: The role of emotion recognition and executive dysfunction	Controlled	16/17	Reading the Mind in the Eyes Test	Ekman 60	TBI (Frontal, Parietal and Temporal lobe lesions)	Patients' recognition of basic emotions, as well as their capacity to detect subtle social emotions, was significantly reduced relative to controls.
2006	Beer et al.	Orbitofrontal cortex and social behavior: Integrating self-monitoring and emotion-cognition interactions	Controlled	16/18	Knowledge of social norms, Self Disclosure task	N/A	Obrito-frontal TBI, Frontal CVA	Patients showed inappropriate social behaviour and were unaware that their performance violated social norms despite being familiar with the norms themselves.
2005	McDonald et al.	Differential impairment in recognition of emotion across different media in people with severe traumatic brain injury	Controlled	34/28	N/A	TASIT/EET (audio & video presentation)	Severe TBI	Patients significantly impaired in recognising and interpreting emotion from static and dynamic pictures as well as conversational tone.

Year	Reference	Title	Paper type	Sample Size (patients / controls)	Social Cognition Tasks	Emotion Recognition /other Tasks	Brain Lesion	Brief Findings
2004	Shamay-Tsoory et al.	Impairment in cognitive and affective empathy in patients with brain lesions: Anatomical and cognitive correlates	Controlled	36 Prefrontal /15 Parietal /19 Healthy	IRI, QMEE	Ekman 60; Affective prosody	TBI, CVA, Tumours, Aneurysm, HSE	Patients with right or left orbital and medial PFC were significantly impaired in both cognitive and affective empathy as compared to parietal patients and healthy controls. Patients with right parietal lesions were also impaired.
2004	McDonald et al.	Social perception deficits after traumatic brain injury: Interaction between emotion recognition, mentalizing ability, and social communication	Controlled	34 TBI (17 frontal)/34 controls	TASIT (part 2&3)	TASIT (part 1)	Severe TBI	Patients had marked difficulty with social perception and basic emotion recognition. They could recognize speaker beliefs only when this information was explicitly provided (i.e. unable to infer meaning of interpersonal exchanges).
2004	Green et al.	Deficits in facial emotion perception in adults with recent traumatic brain injury	Controlled	30/30	N/A	FAB	Chronic TBI	Patients were less accurate than controls on facial emotion perception tasks. This was observed regardless of whether the lesions were focal and specific to areas known to be involved in facial emotion processing or more diffuse.
2003	Hornak et al.	Changes in emotion after circumscribed surgical lesions of the orbitofrontal and cingulate cortices	Controlled	35/48	Own social behaviour questionnaire (previously unpublished)	Modified Ekman 60, Vocal emotion (Hornak et al, 1996)	Tumour Surgery	Patients with bilateral lesions of the OFC or lesions in the ACC showed impairments in voice and face expression and social cognition, whereas patients with unilateral damage in the OFC showed deficits only in emotion recognition.

Year	Reference	Title	Paper type	Sample Size (patients / controls)	Social Cognition Tasks	Emotion Recognition /other Tasks	Brain Lesion	Brief Findings
2003	Kucharska-Pietura et al.	Perception of emotions from faces and voices following unilateral brain damage	Controlled	60/50	N/A	Own (previously unpublished)face emotion recognition and labelling Voice emotion recognition test (own)	Unilateral CVA	Right hemisphere patients showed marked impairment on both emotion recognition and labelling of facial expressions. Negative emotions more impaired than positive. Similar results for emotions conveyed by prosody.
2003	Milders et al.	Neuropsychological impairments and changes in emotional and social behaviour following severe traumatic brain injury	Controlled	17/17	FP, QMEE, Eyes in the mind test, Social Intentions Questionnaire	Ekman 60, Voice emotion recognition	Severe TBI	TBI patients were impaired at recognising facial and vocal emotions and detecting faux pas, but did not show impaired empathy ratings.
2003	Charbonneau et al.	Perception and production of facial and prosodic emotions by chronic CVA patients	Controlled	32/16	N/A	Ekman 60	Unilateral eschemic CVA (frontal, fronto temporal, fronto-partietal, parietal, temporo-paritetal	Patients with right hemisphere damage showed impaired processing of facial (positive and negative) and prosodic (negative only) emotion recognition.
2002	Hopkins et al.	Altered electrodermal response to facial expression after closed head injury	Controlled	15/15	N/A	Modified Ekman 60	TBI	TBI participants showed reduced ability to recognise negative facial expression and reduced electrodermal activity for negative emotions in comparison to controls.

Year	Reference	Title	Paper type	Sample Size (patients / controls)	Social Cognition Tasks	Emotion Recognition /other Tasks	Brain Lesion	Brief Findings
2002	Tranel et al.	Asymmetric functional roles of right and left ventromedial prefrontal cortices in social conduct, decision-making, and emotional processing	Single group	7	Social behaviour assessed by clinician, Family ratings of social conduct, Iowa Rating Scales of Personality Change	N/A	Focal lesions	Patients with lesions in the right ventro-medial prefrontal cortex (VMPC) showed disturbances in social and interpersonal behaviour, whereas patients with lesion in the left VMPC showed intact social functioning.
2001	Happe et al.	Acquired mind-blindness following frontal lobe surgery? A single case study of impaired 'theory of mind' in a patient treated with stereotactic anterior capsulotomy	Single Case	1 post surgery patient/ 1 pre surgery patient/ 19 elderly controls	Story task (Happe et al.,1999); Various TOM tasks (Happe et al.,1999)	N/A	Focal lesions due to surgery (surgery targeting orbitofrontal-thalamic fibres)	The patient who had undergone frontal surgery to address bipolar disorder (BP) showed impaired TOM. However the other patient who had BP but not surgery showed intact TOM.
2000	Blair & Cipolotti	Impaired social response reversal - A case of 'acquired sociopathy'	Single Case	1 patient with frontal lesions/ 1 patient with dysexecutive syndrome but no aggressive behaviour.	Social Cognition tasks (Blair et al., 1995)	Facial Emotion recognition task (Calder et al., 1996);	Focal lesion to orbitofrotnal cortex (TBI).	Patient showed impairment in recognition of some facial expressions (anger and disgust). He also showed difficulties in recognising violations of acceptable social behaviour and attributions of embarrassment and fear in story protagonists.

Year	Reference	Title	Paper type	Sample Size (patients / controls)	Social Cognition Tasks	Emotion Recognition /other Tasks	Brain Lesion	Brief Findings
1998	Stone et al	Frontal lobe contributions to theory of mind	Controlled	10 (5 bilateral OFC; 5 unilateral DLPC/5 controls	False Beliefs tasks; FP	N/A	Focal lesions to frontal cortex (CVA)	
1997	Jackson & Moffat	Impaired emotional recognition following severe head injury	Controlled	15/15	N/A	Facial Recognition Task	TBI	Patients impaired for emotion recognition, especially recognition of negative emotions.

MST= Moral Sense Test (Kamm, 1998); SAT= Social Awareness Test (Dewey, 1991); TOM= Theory of Mind test; FEEST= Facial Expression of Emotion Stimuli and Tests (Young et al., 2002); FP= Faux-Pas Test (Baron-Cohen et al., 1999; Cohen et al., 2006); FASOBT= First- and Second-Order False-Beliefs Tasks (Ehrle et al., 2011); DANVA2-AF=The Diagnostic Assessment of Nonverbal Affect 2–Adult Faces (Nowicki et al., 1994); DANVA2-AP = The Diagnostic Assessment of Nonverbal Affect 2–Adult Paralanguage (Nowicki et al., 1994); MCJ = Moral and Conventional Judgments Test [e.g., (Blair, 1995); Ekman 60 Test (Ekman and Friesen, 1976); EIST= Emotional Inference from Stories Test (Zupan, 2009); IRI = Interpersonal Reactivity Index (Davis, 1980); Reading the Mind in the Eyes Test, (Baron-Cohen et. al., 2001); Faces test (Baron-Cohen et. al., 1997); DEPVT = Dynamic emotion perception video task (Slessor, Phillips, & Bull, 2007); ASI = The ambivalent sexism inventory (Glick & Fiske, 1996); ATWS = The attitudes toward women scale (Spence & Helmreich, 1972); IAT = Implicit association test (Milne & Grafman, 2001); TAS-20 = Toronto Alexithymia Scale (Bagby, Parker & Taylor 1994); TASIT/EET = The Awareness of Social Inference Test, Part 1–The Emotion Evaluation Test (EET) (McDonald & Rollins, 2002); JCT = Joke Comprehension Test (Corcoran et al., 1997); QMEE = Questionnaire Measure of Emotional Empathy (Meherabian & Epstein, 1972); FAB = Florida Affect Battery (bowers et al., 1998).

Anatomical regions: OFC = orbitofrontal cortex; DLPC = dorso-lateral prefrontal cortex; VMPF = ventro-medial prefrontal cortex, OFC = orbito-frontal cortex; ACC = anterior cingulate cortex

4. 2. Study design and Participants

Most of the studies included in this review (33 out of 39) employed a quasi-experimental design, whereby performance on emotion recognition and social cognition tasks of adult patients with various neurological conditions (e.g. traumatic brain injury, stroke, multiple sclerosis, herpes simplex encephalitis, surgical lesions, etc) were compared to a healthy control group matched for age, gender, education and IQ. Two papers employed a quasi-experimental design with no healthy control group (i.e. compared emotion recognition and social cognition between patients with lesions in different areas of the brain). Sample sizes varied from 180 patients/54 controls (DalMonte et al, 2013) to 6 patients/12 controls (Koenigs et al, 2007). Only five studies presented equal numbers patients and controls. On average (across all studies that presented detailed participant data) there were more males than females in both patient (27.4 males vs. 11.6 females) and healthy control groups (18.5 males vs. 11.1 females). The majority of papers reported no significant differences between average ages of patient and control groups.

Four studies presented single cases: two studies had healthy controls for comparison, one compared a patient with frontal lesions and dysexecutive syndrome with another patient with frontal lesions but without dysexecutive syndrome, and another one presented a single patient and no controls.

The majority of studies were conducted on English speaking participants (28 studies). However, 11 studies were conducted with participants whose first language was: French (two studies), Dutch (two studies), Portuguese (two studies), Hungarian (one study), Italian (one study), Hebrew (one study), Chinese (one study), Japanese (one study).

These studies employed a wide range of tasks designed to measure emotion recognition and social cognition. A brief overview of these tasks is presented below, with particular emphasis on their particular strengths and weaknesses.

4. 3. Tasks commonly used for assessing Emotion Recognition and Social Cognition

4. 3. 1. Emotion Recognition

One of the most frequently used and well validated face emotion recognition tasks is the Ekman 60 task proposed by Ekman and Friesen (1971). The Ekman task comprises 60 black-and-white photographs of the faces of ten people (six female, four male) posing the six basic emotions, giving a total of 60 photographs. The participants are asked to decide which emotion name (happiness, surprise, fear, sadness, disgust, or anger) best described the facial expression shown. Although the Ekman 60 test has been shown to be sensitive to certain brain pathology (e.g. Huntington Disease; Milders, Crawford, et al., 2003; Frontotemporal Dementia; Diehl-Schmid, Pohl et al., 2007) several studies have reported ceiling effects when using the Ekman 60 test on non clinical populations (e.g. Young, Perrett, Calder, Sprengelmeyer & Ekman , 2002; Suzuki, Hoshino, & Shigemasu, 2006) thus making comparisons difficult. Consequently a more sensitive battery was developed by Young et al. (2002): Facial Expressions of Emotion- Stimuli and Tests, (FEEST). FEEST which comprises of over 1000 images, incorporates the Ekman 60 Faces test, and adds the Emotion Hexagon test and Emotion Megamixes. These supplemental tests present more difficult to recognise emotions, created by morphing, caricaturing and other computer image manipulations of the original Ekman stimuli, thereby addressing the ceiling effects previously reported in the literature. Most papers included in this review which reported using FEEST as a measure of facial emotion recognition, only use the Ekman 60 subtest test.

Whilst Ekman 60 and FEEST have been extensively used in facial emotion recognition studies with both non-clinical and clinical populations, tasks from larger batteries designed to test emotion perception across several modalities have also been occasionally employed. For example Neumann, Zupan, Babbage, Radnovich, et al., (2012) used tasks from the Diagnostic Assessment of Nonverbal Affect (DANVA, Nowicki and Marshall, 1994). This battery has seven subtests designed to measure participants' perception of facial emotion, emotional postures and gestures as well as their ability to convey emotion through facial emotion, gestures and tone of their voice. The Receptive Facial Expression subtest on DANVA comprises twenty

faces that depict happiness, sadness, anger, and fear and four faces in neutral poses. Unlike the Ekman 60, which comprises only Caucasian faces, the stimuli used in this subtest are multiracial. Unlike Ekman 60 or FEEST the DANVA does not cover surprise and disgust, but it offers the possibility to investigate emotion recognition across several modalities. DANVA is a widely used measure with reported good reliability across different races, sexes, ages and clinical populations, including TBI (Spell and Frank 2000; Radice-Neumann, Zupan, Tomita and Willer, 2009).

A less frequently used facial emotion recognition task is the Florida Test Battery (Bowers, Blonder and Heilman, 1991). It comprises photographs of four different women, each expressing one of five different emotions: happy, sad, angry, frightened and neutral. Unlike the previously presented tasks, it had not been extensively validated on either non-clinical or clinical populations. Additionally it does not address all basic emotions, and only comprises photographs of women. Only one paper included in this systematic review (Green et al., 2004) had used stimuli from this battery in their experimental task.

All tasks presented above rely on static images (photographs) of facial emotion. However, it has been argued that they do not accurately represent 'real' facial emotion (i.e. as observed in natural human interaction), which is highly dynamic, changes rapidly and conveys additional cues by movement itself (Basilli, 1978). To address the dynamic nature of facial emotion, McDonald, Flanagar and Rollins (2002) devised The Awareness of Social Inference Test (TASIT). TASIT includes several subtests (social cognitive tasks are reviewed later), with one emotion recognition task (Part 1: The Emotion Evaluation Test (EET)) which aims to be more ecologically valid. The EET comprises of 28 short video clips of professional actors engaged in an ambiguous or neutral conversation while depicting one of the six basic emotions or a neutral state. The authors claim that in order to make the task as realistic as possible, each actor induced the emotion before enacting the script, and even though the interactions were not completely spontaneous, the resulting vignettes represented a reasonable approximation of a real emotional state. Importantly, the TASIT has been validated on both non clinical participants and TBI patients (McDonald, Flanagar, Rollins, and Kinch, 2003).

All tasks presented so far rely on participants recognising the facial emotion in others. A different approach was used by Dethier, Blairy, Rosenberg and McDonald (2012) who measured spontaneous and posed facial expressivity in TBI patients. They presented participants with faces from the Ekman 60 test showing happiness, sadness and anger and then asked them to imitate these expressions. In the second part of the task, participants had to express the emotion after being exposed to a word (rather than a face). Their expressivity was assessed by two judges, blind to the participant's group (e.g., TBI or control). This task has the advantage that it measures the accuracy of production as well as recognition of emotion.

Another non-visual emotion recognition task used in the literature is the Emotional Inference from Stories Test (EIST; Neumann, Zupan, Babbage, Duncan, Radnovich et al., 2002) which comprises of twelve short stories. After reading the story, participants simply have to decide which the four basic emotions (happiness, sadness, anger and fear) was predominant for the character in the story.

Another approach to assessing emotion recognition without visually presenting faces is the Toronto Alexithymia Scale (TAS-20; Bagby, Parker & Taylor 1994). Alexithymia is a multifaceted personality trait which refers to difficulties identifying and describing emotional states in self and others. Alexithymia is often associated with disturbances in emotion regulation and social functioning (e.g. FeldmanHall, Dalgleish and Mobbs, 2013). The TAS-20 is a self-report 20-item questionnaire which has been shown to have good cross-cultural reliability and validity (e.g. Bressi et al., 1995; Taylor et al., 2003).

4. 3. 2. Social Cognition

Social cognition refers to the ability to understand that one's own (and other's) behaviour is guided by his/her own internal thoughts, beliefs, emotions and intentions, or in other words, to develop a Theory of Mind (ToM; Firth and Firth, 2010). A ToM also allows one to understand that others may hold a different point of view than one's own: cognitive empathy (Rogers, Dziobek, Hassenstab, Wolf, and Convit, 2007). Thus ToM tasks and cognitive empathy tasks are generally used to assess social cognition. Usually, these tasks require participants to infer the subtle

emotional states of characters depicted in short stories, cartoons or human actors from still images or video clips. Some of these tasks are extensively validated and have been employed in several studies; others appear in only one study.

Typical ToM tasks involve the attribution of false beliefs. First and Second Order False Beliefs Tasks (FASOBT; Samson, Apperly, Chiavarino and Humphreys, 2004; Ehrle, Henry, Pesa & Bakchine, 2011) present participants with videos or verbal stories of a person who placed an object in one of two identical boxes in full view of another person. When the second person left the room, the first actor swapped the boxes. Upon returning the second person has to locate the objects. In order to correctly solve this task, the participants have to infer the second character's false belief and chose the empty box. In half of the trials the participants could see where the first actor has hidden the object (Reality Known) whereas in the other half they could not (Reality Unknown); this ensured participants' attribution of false belief could not be disrupted by their own knowledge of the correct answer (Samson et al, 2004). A similar variant of this task is the aim to test participants' ability to deduce another person's mental state.

Several studies used moral judgment tasks and tasks tapping onto knowledge of social norms to assess social cognition. There seems to be a consensus in the literature that social emotion processing (e.g., compassion, shame, guilt) and judgment of moral dilemmas are closely interlinked (Koenigs, Young, Adolphs, Tranel, et al., 2007). Moral dilemmas (e.g. Moral Sense Test, Kamm, 1998; 50 Dilemmas, Greene, Nystrom, Engell, Darley and Cohen, 2004) are fictional vignettes of social situations which present the participant with a forced choice between two alternative actions one of which will inevitably disadvantage one of the parties involved in the vignette. Patients with prefrontal brain lesions often produce an abnormally utilitarian response on these dilemmas, which requires the participant to disregard an emotional response against inflicting direct harm to another person, thereby showing diminished emotional responsibility (e.g. sacrifice their own child to save some strangers). Other tasks (e.g. Social Awareness Test; Dewey, 1991) present participants with nine short stories describing both usual and unusual social interactions; participants have to judge the behaviour of the characters in those vignettes as "fairly normal", "strange" or "shocking behaviour". Although this task has shown good reliability in participants with Asperger's syndrome (Dewey, 1991) and

autism (Callenmark, Kjellin, Ronnqvist and Bolte, 2014) other studies have failed to show similar reliability in non-clinical populations (e.g. Soderstrand & Almkvist, 2012). Variations of these tasks have also been proposed (e.g. The Moral and Conventional Judgments Test; Blair, 1995; Blair and Cipolotti, 2000).

Another instrument commonly used in several studies is the Faux Pas recognition test (Stone, Baron-Cohen and Knight 1998). This test comprises of several stories in which a character unwittingly makes an awkward comment not realizing that it might hurt another person. In order to detect a faux pas, the participant has to understand the beliefs and points of view of both characters in the respective social situation and to correctly infer the emotional states associated with them (e.g. cognitive empathy). There are reports of good reliability of the instrument in the literature (e.g. Soderstrand and Almkvist, 2012).

In contrast, the Joke Comprehension Test (Corcoran et al, 1997) or Cartoon task (Happe, Brownell and Winnder 1999), use a series of cartoon drawings to test the participant's ability to appreciate the humour based on understanding the character's thoughts and predicting the intentions of various characters in the cartoon series. Variations of these tasks are aimed at detecting whether participants understood that the cartoon character is operating on a false belief or is in violation of a social norm.

Tasks that tap into cognitive and emotional empathy have also been used to assess social cognition. The Interpersonal Reactivity Index (IRI, Davies, 1980) is often used to assess cognitive empathy. The IRI is a 28 item self-report measure which includes four subscales, each tapping different aspects of empathy: the Perspective Taking Subscale, which measures the tendency to spontaneously adopt the psychological point of view of others; the Fantasy Subscale, which assesses the tendency to resonate with the feelings and actions of fictitious characters from books and films; the Empathetic Concern Subscale, which assesses feelings of sympathy and concern towards the misfortunes of others; and the Personal Distress Subscale, which assesses feelings of anxiety and concern about self in difficult social situations.

The Questionnaire Measure of Emotional Empathy (QMEE; Meherabian & Epstein, 1972) is a 33 item self-report measure designed to assess emotional empathy, which is the tendency to report emotional arousal in reaction to the perceived emotional

experiences of other people (e.g., becoming tearful as a result of seeing someone else cry). The QMEE has been one of the most widely utilized instrument used to measure emotional empathy (Davis, 1994, Chlopan, McCain, Carbonell, & Hagen, 1985)

All the tasks presented so far rely mostly on verbal reasoning. Nonetheless, visual tasks have also been used to assess social cognition. A widely used task, the Reading the Mind in the Eyes Test - revised (Baron-Cohen Wheelwright, Hill, Raste and Plumb, 2001) requires participants to match the complex social emotions displayed in 36 photographs of the eyes of a human actor, with verbal descriptions (such as playful, worried, fantasising, pensive, reflective, flirtatious, distrustful, suspicious etc). Several studies have reported that Reading the Mind in the Eyes Test showed good cross cultural reliability in both clinical and non-clinical populations (e.g. Fernandez-Abascal, Cabello, Fernandez-Berrocal, and Baron-Cohen, 2013; Hallerback, Lugnegard, Hjarthag, and Gillberg, 2009; Yildirim, Kasar, Guduk, Ates, et al., 2011; Rojas, Serrano, Dillon, Bartoloni, et al., 2011; Prevost, Carrier, Chowne, Zelkowitzet al., 2014).

The Awareness of Social Inference Test (TASIT;McDonald et al., 2002) addresses social cognition, in addition to basic facial perception, through short video clips of actors engaged in sarcastic exchanges, sincere exchanges or lies. Participants are asked several questions assessing their understanding of the actors' emotional state (focusing on complex emotions such as annoyance and contempt), beliefs (first-order theory of mind) and intentions towards their conversational partners (second-order theory of mind). This task has been reported to have good cross cultural ecological validity and reliability in healthy controls (Westerhof-Evers, Visser-Keizer, McDonald and Spikman, 2004). A similar, albeit simpler task, the Dynamic Emotion Perception Video Task (Slessor, Phillips, & Bull, 2007) presented participants with video clips portraying characters interacting. Participants had to chose a word out of several options that best described the complex social emotion portrayed by the characters (e.g. frustrated, excited, bored).

Finally, although a plethora of instruments to assess social cognition with readily available psychometric proprieties have been published up to date, some studies used newly developed measures which had not been validated on non-clinical

populations. For example, Hornak et al., (2003) proposed a social cognition questionnaire which comprised items that tapped into emotional empathy, emotion recognition, public behaviour, interpersonal relationships and antisocial behaviour. Other studies (e.g., Tranel et al, 2002) used clinical interviews to assess social behaviour, seconded by family ratings of social conduct.

4. 4. Changes in Emotion Recognition and Social Cognition

Although all the studies selected in this review included at least some participants (if not all) who had frontal lesions, these lesions were not homogenous. Thus, the studies were grouped according to the type of brain lesion: traumatic brain injury (TBI); focal brain damage due to post operative lesions, cerebro-vascular accident (CVA) or unspecified aetiology; diffuse brain injury (multiple sclerosis - MS); and multiple types of lesions, both focal and diffuse (e.g. TBI, CVA, Anoxia, Herpes Simplex Encephalitis - HSE).

4. 4. 1. Changes in basic emotion recognition and social cognition in patients with TBI (N=24)

The majority of papers included in this review (n=24/39) described changes in basic emotion recognition and/or social cognition in participants who had TBI. Twelve studies investigated changes in basic emotion recognition, four looked at changes in social cognition and eight looked at both emotion perception and social cognition in the same clinical population.

4. 4. 1. 1. Emotion recognition

Overall, the majority of studies reporting on patients with TBI included in this review found various degrees of impairment in the ability to recognise facial emotion recognition. A plethora of studies reported global deficits in facial emotion perception across all emotions using Ekman 60 stimuli or modified versions of the task (Green, Turner and Thompson, 2004; Henry et al, 2006; Mitchell, Avny & Blair, 2006; Henry,

Phillips, Beatty, McDonald et al., 2009; Williams and Wood, 2010; Callahan, Ueda, Sakata, Plamondon and Murai, 2011; Spikman, Timmerman, Milders, Veenstra and van der Naalt, 2012; Dal Monte, Krueger, Solomon, Schintu, et al., 2013; Spikman, Milders, Visser-Keizer, Westerhof-Evers, et al., 2013).

Several studies, however, showed that only the recognition of negative facial emotions is impaired in patients with frontal TBI whilst positive emotions are recognised at the same level as controls (Jackson & Moffat, 1997, Blair & Cipolotti, 2000; Hopkins, Dywan & Segalowitz, 2002, Kemp, Berthel, Dufour, Despres, et al., 2013). Interestingly, Hopkins et al. (2002) report that TBI participants additionally showed reduced electrodermal activity for negative emotions in comparison to controls. This suggests that the impairment in negative emotion recognition is severe, since both implicit and explicit recognition mechanisms were affected, whereas mechanisms underlining the recognition of positive emotion (e.g., happiness) is relatively well preserved. However, research on non-clinical participants suggested that positive emotions are more accurately recognised because the Ekman stimuli contain just one positive emotion (happiness) and five different negative emotions, which may create confusion between different negative emotions and mislabel them (e.g. Calvo & Lundqvist, 2008). In order to reduce this effect, Hopkins et al. (2002) did not use all negative emotion stimuli in order to reduce repeated exposure and prevent participants habituating to the negative emotions.

McDonald and Saunders (2005) found that only some participants with TBI (eight out of 34) showed impaired facial emotion recognition from still photographs. However the authors report that when a different task was used (e.g., Ekman 60), the majority of participants (22 out of 34) showed significant impairment in emotion recognition. Nevertheless, they argue that the Ekman stimuli may be too difficult for people with TBI, because of their poor visual quality and the fact that they appear "dated" (McDonald and Saunders, 2005). Since several studies report ceiling effects when using the Ekman 60 on healthy populations (e.g. Young, et al., 2002; Suzuki, et al., 2006) it becomes problematic to choose a task that is comparable in difficulty for both patients and healthy controls. Thus, Henry et al., (2006) used a self-report measure which taps into symptoms associated with Alexithymia (TAS-20) and found that TBI patients showed difficulties in recognising and describing emotions in

comparison to healthy controls. Notably, effects sizes were larger for emotion recognition than description. McDonald, Rosenfeld, Henry, Togher et al., (2011) assessed TBI patients for both Alexithymia (using TAS-20) and visual facial emotion recognition (using Ekman 60 test) and found that patients were impaired recognising facial expressions (especially fear) but there was no correlation between emotion recognition scores and alexithymic symptoms. The authors concluded that even though TBI patients reported significantly greater alexithymic symptoms than healthy controls, alexithymia as measured by TAS-20 does not appear to capture the difficulties TBI patients show with facial emotion perception.

Impairments in facial emotion recognition are also reported in studies which employed dynamic facial emotion stimuli. McDonald and Flanagan (2004) found that TBI participants performed significantly lower than controls when recognising emotion from video clips (the TASIT: EET task) suggesting a global impairment in facial emotion recognition across all emotions. In contrast, McDonald and Saunders (2005) found that patients with severe TBI showed performance similar to healthy controls on the same task (TASIT: EET). Whilst these results appear contradictory, the heterogeneity, both in location and severity, of the TBI lesions reported in the patient groups presented in these two papers, prevent a direct comparison. However, it is generally agreed that patients with frontal pathology are more likely to exhibit emotion perception difficulties, regardless of stimulus type (static, dynamic) or modality (auditory, visual; McDonald and Saunders, 2005).

Deficits in emotion recognition across several modalities have also been reported. Milders, Fuchs and Crawford (2003) found that patients with frontal TBI had significant difficulties in recognising emotion from voice and facial emotion from still photographs in comparison to healthy controls. McDonald and Saunders (2005) found that patients with severe TBI were impaired in emotion recognition from both audiovisual and audio stimuli. Similar effects were reported in single case studies and quasi-experimental studies without a healthy control group. For example, Mitchell et al., (2006) presented a single case study of a patient with bilateral frontal TBI who was impaired on both facial and auditory emotion recognition. Neumann et al., (2012) investigated a large sample (N=106) of patients with moderate TBI and found that patients with dysosmia (olfactory dysfunction) showed impairments in facial and vocal affect recognition in comparison to patients without dysosmia who

presented with intact emotion recognition (both auditory and visual). This is probably because olfactory cortices, such as the orbitofrontal areas and insula, are also involved in affect recognition.

In addition to impairments in facial emotion recognition and matching, McDonald, Li, De Sousa, Rushby, et al. (2011) also found reduced automatic facial muscle activity in response to exposure to faces displaying emotion (Ekman 60 stimuli) in patients with TBI. Similarly, Dethier et al., (2012) found that TBI patients were impaired in their ability to pose sad facial expressions and also showed reduced intensity for spontaneous facial expressions of sadness in comparison to healthy controls.

Most of the studies described above reported on patients with focal TBI. Green et al. (2004) reported that patients with recently acquired TBI and either focal or diffuse frontal damage, were significantly less accurate at tasks involving discrimination and labelling of facial emotion than matched controls, but were non-impaired performance at emotionally neutral tasks.

4. 4. 1. 2. Social Cognition

All studies reviewed here reported impairments of various components of social cognition in patients with TBI. As most studies employed several social cognition tests, it is difficult to separate results based on the task used. Instead a synthesis of results will be presented based on overall findings across several tasks used.

Impairments in ToM have been frequently reported in patients with TBI. For example, Milders et al., (2003), reported that participants with severe TBI found it more difficult to detect inappropriate social behaviour (Faux Pas test) than healthy controls despite the fact that they showed similar levels of story comprehension as healthy controls. Interestingly, TBI patients did not show impaired empathy ratings, and were able to detect subtle social emotions (as assessed by the Mind in the Eyes Test) at levels comparable to controls (Milders et al, 2003). However, in the absence of detailed information about the locus of the lesions in the patient sample, it is difficult to link this pattern of functional impairment to specific brain areas. This limitation was addressed by Geraci, Surian, Ferraro & Cantagallo, (2010) who reported that

patients with focal damage in the ventro-medial prefrontal cortex (VMPC) were impaired on the Faux Pas test. However, patients with damage to dorsolateral prefrontal cortex (DLPC) showed intact Faux Pas judgements. Spikman et al., (2012) reported that patients with frontal TBI showed impaired detection for inappropriate behaviour on the Faux Pas task, and presented with reduced ability to infer mental states from cartoons and reduced empathy on a self report measure (EEQ).

In contrast to Milders et al, (2003) Geraci et al, (2010) reported impairments on the Mind in the Eyes Test in both groups (VMPC and DLPC) of patients. However, it is important to note that these results have been reported on a small sample sizes (11 VMPC, 7 DLPC). In contrast Xi, Zhu, Niu, Zhu, et al., (2011) assessed a larger sample of TBI patients with focal damage to the VMPC (n=16) and DLPC (n=14) found that both groups of patients with prefrontal lesions showed impaired performance on the Faux Pas task. Similar to Geraci et al., (2010), Henry et al., (2006) also reported that TBI patients performed lower on the Mind in the Eyes test in comparison to healthy controls. Notably, this effect was of smaller size than the impairment they found with basic emotion recognition. However, unlike previous studies clinical samples (i.e. Geraci et al., 2013 and Xi et al., 2011) Henry et al's patient sample contained not only participants with frontal damage, but also with temporal and parietal damage. Additionally, half the sample had no information available on the lesion site. These limitations prevent a direct comparison with previous studies. A study by Martins, Faisca, Esteves, Simao, et al. (2012) found that patients with lesions in the prefrontal cortex showed significant impairments in recognising two social emotions: arrogance and jealousy, but relatively intact recognition of guilt. There were no differences between patients with left or right hemisphere damage, but the impairment pattern was more pronounced in patients with bilateral damage.

Judging complex social emotion from static black-and-white images (Mind in The Eyes Test) or judging complex social interactions from short written stories could be more difficult than in real life situations. Thus, McDonald et al. (2004) investigated participants' ability to recognise the mental state of others (beliefs, emotions) from videotaped vignettes. They found that severe TBI participants were less able than controls to infer speaker's beliefs (first order theory of mind) and even more impaired at judging what they intended their conversational partners to believe (second order

beliefs). Interestingly, McDonald et al (2004) did not find impairments in either social or basic emotion perception. Some patients showed significant difficulties in recognising basic facial emotion but unimpaired social cognition and vice versa, despite common frontal pathology.

Martins, Faisca, Esteves, Muresan, et al., (2012) investigated the ability to perform moral judgements in participants with TBI. They found atypical (utilitarian responses) to personal moral dilemmas, as well as difficulties in recognising complex social emotions in comparison to healthy controls. This study's findings are very important because they link recognition of complex social emotions with the ability to adequately judge moral dilemmas. Due to impaired social emotion processing (or reduced empathy) patients with frontal TBI do not perceive the moral conflict in these dilemmas and tend to rely almost exclusively on cognitive processing. Therefore they produce only utilitarian judgements through abstract reasoning and cost-benefit analysis. The reduced empathy hypothesis is also supported by studies of Milders et al. (2003) and Spikman et al. (2012) who reported reduced empathy in patients with frontal TBI on a self-report measure (Questionnaire Measure of Emotional Empathy; Meherabian & Epstein, 1972). Similar results were reported by Blair & Cipolotti (2006) on a single case study of a patient with extensive right frontal TBI. The patient exhibited high levels of aggressive behaviour, a lack of empathy and guilt towards others, had difficulties in recognising violations of acceptable social behaviour and was impaired in the ability to infer feelings of embarrassment and fear in story protagonists.

However, not all aspects of social cognition have been shown to be impaired in patients with TBI. For example, McDonald, Saad and James (2011) did not find any impairment on an implicit social cognition measure (implicit association test (IAT); Milne & Grafman, 2001). They found that frontal TBI participants responded faster to items that are consistent with stereotypes (e.g., male–strong, female–weak) in comparison to items that contradict stereotypes (e.g., male–weak, female–strong). Typically, non-clinical participants respond to the IAT in a manner congruent to their internalised social stereotypes, although these responses are not usually produced in an explicit task. Nevertheless, accessing stereotypical views remains a very small part of the wider social cognition function, and unlike to change the global picture of impairment in TBI.

4. 4. 2. Changes in basic emotion recognition and social cognition in patients with focal brain damage (N=9)

Eleven studies included in this review described changes in basic emotion recognition (n=2), social cognition (n=5), or both (n=2).

4. 4. 2. 1. Emotion Recognition

Similar to the findings in the TBI literature, Kucharska-Pietura, Phillips, Gernand and David (2003) reported that recognition of negative facial emotions is particularly impaired in patients with right hemisphere lesions (lesions due to single CVA). Charbonneau, Scherzer, Aspirot and Cohen (2003), however, found that participants who had lesions in the right hemisphere (RH) underperformed at tasks involving identification of happiness, surprise and fear from facial stimuli in comparison to both controls and participants with left hemisphere (LH) lesions. Thus, impairments in positive emotions (happiness) in patients with RH lesions have also been reported. Interestingly, they found that RH participants were impaired on tasks involving verbal discrimination, imitation and production of negative emotions (fear, sadness, anger).

Deficits in emotion recognition across several modalities have also been reported. Hornak et al. (2003) found that patients with bilateral lesions (due surgical excisions) of the orbitofrontal cortex (OFC) or lesions in the anterior cingulate cortex (ACC) showed impairments in voice and face emotion recognition, whereas patients with lesions in the dorsolateral regions are unimpaired.

4. 4. 2. 2. Social cognition

Tranel, Bechara and Denburg (2002) compared patients with focal lesions of the left or right ventromedial prefrontal cortex (VMPC) and reported that only patients with lesions in the right VMPC showed disturbances in social and interpersonal behaviour (as assessed by clinician and from reports of the patients' close family), whereas patients with a lesion in the left VMPC showed intact social functioning. However, the

small sample size (n=7), lack of a control group, and the usage of non-standardised tasks represent clear limitations of this study. Koenings et al, (2007) suggested that patients with lesions in the VMPC produce an abnormally utilitarian pattern of responses on moral dilemmas tests, which require the participant to disregard an emotional response against inflicting direct harm to another person. This pattern of responses was not found on participants with lesions outside VMPC. It should be noted however, that there were only six patients with lesions in the VMPC in this study. Nevertheless, another study carried out on a larger sample (29 patients) also showed atypical (utilitarian responses) to personal moral dilemmas, as well as difficulties in recognising complex social emotions in comparison to healthy controls (Martins, Faisca, Esteves, Muresan, et al., 2012).

Stone, Baron-Cohen and Knight (1998) found that patients with bilateral damage to the orbito-frontal cortex (OFC) showed good performance on first- and second- order false belief tasks, but were impaired on the Faux Pas test. In contrast, patients with left dorsolateral lesions performed at comparable levels to healthy controls in the Faux Pas test and failed only in the versions of the tasks with high working memory demands. Hornak et al, 2003 found that patients with bilateral focal damage in the OFC scored lower than controls on self-report measures of empathy (e.g., difficulties noticing emotional states in others, not caring what others think) and social behaviour (e.g., not being close to their family and partners, having difficulties in making and maintaining relationships). Interestingly, the authors note that these effects were smaller than in previous studies conducted with patients with traumatic lesions to the VMPC. Similarly, Beer et al., (2006) reported that patients with focal lesions to the OFC made socially inappropriate self-disclosures when talking to a stranger and were unaware that their behaviour violated social norms despite unimpaired knowledge of the social norms themselves. Interestingly, patients with damage to medial and lateral regions of the prefrontal cortex were more aware of the inappropriateness of their behaviour despite having comparatively larger lesions. Beer et al. therefore suggested that the OCF also has a role in self monitoring in social situations.

Similar results have also been reported in single case studies. Happe, Malhi and Checkley (2001) reported reduced ability to infer mental states of characters in a series of cartoons in a patient with post surgery damage to the orbitofrontal cortex,

which suggests empathy deficits. The patient also showed a similar pattern of impairment on a verbal task (short story task) requiring him to make inferences about a character's thoughts, feelings and intentions. Interestingly, the patient showed unimpaired performance on tasks which did not require ToM judgements. Kemp et al. (2013) found that a patient with focal damage to the caudate nucleus following a stroke also showed a loss of empathy, difficulties in detecting faux pas and difficulties recognizing social emotions in others (as assessed by the Mind in the Eyes test). Although the damage was not direct to the OFC, the caudate nucleus damage resulted in the disconnection of the sub-cortical orbito-frontal loop, thereby disrupting the normal functioning of the OFC. Interestingly, not all aspects of ToM were affected. The patient showed unimpaired judgements of the appropriateness of social behaviours (as assessed by Social Situations Test), unimpaired moral judgements (as assessed by Moral Judgement Tasks) and also unimpaired first- and second-order false beliefs.

4. 4. 3. Changes in basic emotion recognition and social cognition in patients with diffuse brain damage (N=3)

All three studies included in this section report on patients with multiple sclerosis (MS), which is an inflammatory disorder affecting the myelin sheathing of axonal fibres in the central nervous system, which is thought to be the result of destruction by the immune system or failure of the myelin-producing cells (Nakahara, Maeda, Aiso and Suzuki, 2012). Axonal damage in MS eventually results in disconnection of frontal-subcortical brain tracts involved in the processing of emotional signals (Ruffman, Henry, Livingstone, & Phillips, 2008).

Henry et al. (2009) reported that participants with MS had difficulties recognising facial expressions of the basic emotions of fear and anger, but showed recognition performance similar to controls for surprise, sadness, disgust and happiness (Ekman 60 task). Somewhat similar results were reported by Phillips, Henry, Scott, Summers et al., (2011) who found that people with MS showed reduced performance in comparison to controls at tasks involving recognition of all basic emotions from static (photographs, FEEST, Young et al, 2002) and dynamic (video clips, Slessor et al,

2007) stimuli. Although Mike, Strammer, Ardi, Orsi et al. (2013) did not use the Ekman 60 task, they also reported impairments across all basic emotions in patients with MS on another basic emotion recognition task (Faces test; Baron-Cohen et. al., 1997)

Difficulties in social cognition have been reported by Henry et al, (2009) who found that MS patients performed significantly below healthy controls in identifying complex social emotions from pictures of the eye region (Mind in the Eyes Test). Mike at al., 2013 reported similar results on the Mind in the Eyes Test, but also found that MS participants had difficulties detecting Faux Pas in a series of stories.

4. 4. 4. Changes in basic emotion recognition and social cognition in patients with lesions of different aetiology (N=3)

There are conflicting reports regarding basic emotion recognition in patients with multiple lesions (e.g., frontal and parietal lobes). Shamay-Tsoory, Tomer, Goldsher, Berger et al, (2004) did not find impairments in basic facial emotion recognition (e.g., Ekman 60) or affective prosody in patients with lesions in the prefrontal and parietal regions (TBI, stroke, brain tumours, aneurysm, herpes simplex encephalitis). In contrast, Njomboro, Humphreys and Deb (2014) found that patients with lesions in the fronto-temporal and parietal regions (stroke, TBI, anoxia and herpes simplex encephalitis) performed significantly worse than controls across all emotions on both Ekman 60 task and Emotion Hexagon Test. There were no differences however, between patients who had frontal and temporal lesions.

Two studies reported changes in various components of social cognition. Shamay-Tsoory et al, (2004) found that patients with lesions in the orbital and medial regions of the prefrontal cortex were significantly impaired in both cognitive and affective empathy (as assessed by QMEE and IRI) when compared to controls or patients with lesions in the parietal lobes. This pattern of impairment was present regardless of the laterality of the lesion. Interestingly, patients with right parietal lesions were also impaired in cognitive and affective empathy, whereas patients with left parietal lesions were not impaired at tasks measuring empathy.

Chivavarino, Apperley and Humphreys (2009) investigated the ability to indentify pretended actions in patients with lesions in the frontal, parietal and temporal regions due to stroke, anoxia and herpes simplex encephalitis). They found that patients with parietal and frontal damage experienced more difficulties than controls in discriminating between real and pretended actions. Notably, patients with parietal damage were more impaired than patients with frontal damage. However, the patients with frontal damage showed impairment judgements of intentionality of the pretended actions, thereby suggesting poor ToM skills. Njomboro, et al., (2014) reported that that patients with lesions in the fronto-temporal and parietal regions showed impaired moral reasoning judgements (as assessed by MST, Kamm, 1998), had difficulties in assessing the appropriateness of social behaviours (SAT; Dewey, 1991) and showed impaired ToM judgements (first- and second-order false beliefs).

5. Discussion

The majority of papers reviewed seem to be in agreement that impairments in emotional recognition and social cognition are very often associated with damage in the frontal cortex, especially in the orbitofrontal and ventromedial areas. However, the degree of impairment remains a subject of debate. For example, studies reporting on focal damage to the orbitofrontal cortex have suggested that the perception of negative emotions is more affected than the perception of positive emotions (e.g., Kucharska-Pietura et al., 2003). Reduced autonomic responses to negative emotions in patients with ventromedial lesions seem to suggest that impairments can occur before emotional processing reaches conscious awareness (e.g., Hopkins et al. 2002). In contrast, other studies report a global impairment across all emotions (e.g., Hornak et al., 2003). Interestingly, patients with lesions in both orbitofrontal and ventromedial areas seem to have difficulties expressing as well as perceiving emotions (e.g., Dethier et al, 2012).

Since studies conducted on participants with very similar focal damage to a specific area are not in agreement, it is perhaps not surprising that studies which investigate patients with lesions across several regions of the frontal lobes (e.g., TBI) are in a similar position. Some TBI studies report impairments for negative emotions only

(e.g., Jackson & Moffat, 1997, Blair & Cipolotti, 2000; Hopkins, et al, 2002, Kemp, et al., 2013) whereas others report impairments across all emotions (e.g., McDonald & Flanagan, 2004; McDonald & Saunders 2005). There seems to be a relative consensus in the literature that reduced emotional recognition is ubiquitous in TBI patients, regardless of the modality and stimuli or tasks used. Moreover, a wide range of lesions sites (frontal e.g., Blair et al., 2000; McDonald et al., 2011; Callahan et al., 2011; fronto-temporal e.g., Martins et al.2012; prefrontal e.g., Spikman et al. 2012) and injury severity (severe e.g., McDonald et al. 2011; or moderate e.g., Spikman et al., 2013) seem to produce a similar pattern of impairment.

The literature distinguishes between studies that have been conducted on TBI patients with focal lesions (e.g., DalMonte et al., 2013), versus studies which investigated patients who presented with both focal and diffuse damage subsequent to TBI (e.g., Green et al., 2004). However, since most TBI injuries occur through rapid deceleration (e.g., traffic accidents and other forceful collisions), diffuse axonal injury often occurs in TBI as a result of asymmetrical mechanical loading at cellular level (e.g., Smith, Meaney and Shull, 2003; Cloots, van Dommelen, Kleiven and Geers, 2013). Thus it seems unlikely that the majority of patients with TBI would only exhibit focal damage without any diffuse damage at all. Since emotion processing is carried out across multiple and highly complex neuro-anatomical circuits, which are not independent of each other, damage to one would affect the functioning of the rest of the network. The high interconnectivity of brain areas involved in emotion processing (prefrontal cortex, amygdala and temporal lobes, and regions of the parietal cortex) may explain why patients with lesions in any of these areas exhibit a similar pattern of impairment.

This idea is supported by the reported variability in emotion recognition abilities of patients with diffuse brain damage (e.g., MS). Whilst some papers reported impairments only for fear and anger (e.g., Henry et al., 2009), others reported global emotion recognition impairment (Phillips et al, 2011; Mike et al, 2013). This is probably because a variable number connections between the processing areas described above had been affected by the MS and thus different degrees of impairment were observed. Of note, both the Henry et al., and Phillips et al., studies have been conducted on similar sample sizes and used similar facial recognition tasks. However, there was no imaging data to allow direct comparison of white

matter lesions between samples. However, Mike et al. used 3T MRI scans to determine the extent of lesions and reported that impairments in facial emotion recognition correlated with lesions of fibre tracts interconnecting cortical regions related to emotion processing.

The finding that deficits in emotion recognition are almost always reported in patients who also present with impairments in social cognition seems to add support to the idea that intact emotion recognition is a prerequisite for effective social cognition. Indeed, impaired ability to detect and recognise emotional states in others would make "hot" social cognition (e.g., the ability to empathise with others) very difficult. Reduced empathy has often been reported in patients with lesions in the orbitofrontal and ventromedial prefrontal cortex (various aetiologies) that have difficulties in perceiving moral conflict and tend to rely almost exclusively on cognitive processing, thereby producing "utilitarian" judgements (e.g., Stone et al, 1998; Milders et al., 2003; Koenings et al., 2007; Spikman et al, 2012). Impairments in both cognitive and affective empathy have also been linked to damage to the orbitofrontal cortex (e.g., Shamay-Tsoory et al, 2004)

Additionally, detection and interpretation of complex social emotions (e.g., "guilt" or "regret") would be very difficult (if not impossible) without the understanding of the six basic emotions. Indeed, impairments in both complex social emotion processing and basic emotion recognition have been extensively reported (e.g., Henry et al, 2006, Neuman et al, 2012; Martins et al.,2012; Spikman et al, 2012; Kemp et al, 2013). Notably, difficulties with "hot" social cognitions are reported not only for patients with focal lesions in the ventromedial prefrontal cortex, but also in patients with diffuse damage in the frontal white matter due to MS. As in the case of emotion recognition, Mike et al. 2013 reported that impairments social perception correlated with lesions of fibre tracts interconnecting various cortical regions including the VMPC.

Impairments in ToM (or "Cold" social cognition skills) are also widely reported. There seems to be a relative consensus in the literature that damage to the ventromedial and dorsolateral prefrontal cortex (due to TBI, stroke, surgical lesions, etc.) is also followed by impairments in "cold" social cognition (e.g., Tranel et al, 2002; Geraci et al, 2010; Njomboro, et al., 2014). Since ventromedial areas are also heavily involved

in basic emotion processing it is not surprising that the majority of studies which looked at "cold" social cognition and emotion recognition in patients with damage in those areas report impairments in both. However, it has been argued that the reported deficits in ToM may not be strongly related to impairments in basic emotion recognition. Since most tasks used to assess ToM are in the form of short stories which participants have to remember and manipulate mentally to extract relevant information upon which to base their decisions, deficits in working memory (also associated with frontal lobe damage) may explain some of the impairments seen in these tasks (McDonald, 2013).

Whilst all the studies reviewed here have a number of limitations (e.g., unequal patient/control samples or even absence of a control group, small sample sizes, unequal gender representation, the use of instruments with poor or no validation), the majority of studies were found to be of good or sufficient quality for the purpose of this qualitative synthesis. The overall conclusion of this review is that the majority of evidence suggests that frontal lobe damage is very often followed by a certain degree of impairment in emotion recognition and social cognition, which may explain why carers and families of patients with frontal brain damage often report significant changes in their personality and social behaviour (e.g. Hoefinen, et al., 2001; Tesa et al., 2006). Reduced ability to understand how others are feeling significantly impacts the selection of appropriate responses, which in turn limits the success of social interactions. Thus, it seems essential that patients with frontal damage should be offered interventions aimed at retraining their basic emotion processing and social skills.

Although steps have been taken to ensure this review is comprehensive and unbiased, it has nevertheless several limitations. First, due to the wide range of tasks used, a quantitative comparison of the results across all papers was not possible. It is therefore difficult to compare the performance of patients with different lesions and determine which lesions are more likely to create more marked impairments, so remediation strategies can be more effectively directed towards the patients who need it most. Second, this review only included studies published in peer review journals. However, it is well known that studies which report significant results are more likely to be published than ones which report non-significant results (e.g., "the file drawer problem"; Rosenthal, 1979). Therefore, the true occurrence of frequency

of these emotional and social difficulties in the general population (e.g., patients with TBI, MS) cannot be accurately inferred from this review. Finally, this review focused only on adults with frontal brain damage. Future reviews should also assess the changes in emotion recognition and social cognition in children and young persons.

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7. Appendix

Table 3: A summary of participants' gender and average age across all studies included in the review, as well as study quality ratings.

Year	Reference	Patient Group			Healthy Control Group			Study Quality
		Male	Female	Age (M; SD)	Male	Female	Age	
2014	Njomboro, et al.	36	13	48.75; 11.8	unclear	unclear	unclear	++
2013	Spikman, et al.	34	17	37.5; 14.9	17	16	37.9; 13.2	++
2013	Mike, et al.	31	18	39.8; 9.31	13	11	36.7; 7.27	++
2013	Kemp et al.	1	0	44	12	0	44.8; 2.5	+
2013	Dal Monte et al.	180	0	N/A	53	0	N/A	+
2012	Spikman et al.	20	8	30.1; 12.9	17	16	37.9; 13.2	++
2012	Neumann et al.	75	31	39.5;N/A	0	0	0	+
2012	Martins et al.	17	12	29.31; 3.25	25	16	27.9; 5.7	++
2012	Martins et al.	20	12	29.9; 6.07	25	16	27.9; 5.7	++
2012	Dethier et al.	5	18	46.34; 13.14	12	17	42.22; 14.1	+
2011	Xi, et al.	16	14	34.7	14	16	34.76	++
2011	Phillips et al.	4	28	N/A	9	24	N/A	+
2011	McDonald et al.	15	7	44; 14.8	13	12	33.4; 12.9	+
2011	McDonald et al.	10	10	43.1; 13.3	9	11	42.5; 11.6	++
2011	McDonald et al.	17	4	48.4; 3.8	12	8	36.2; 13.2	+
2011	Callahan et al.	10	4	38; 12.9	11	11	40; 7.7	++
2010	Williams et al.	53	11	35.84; 13.33	53	11	36.9; 14.24	++
2010	Geraci et al.	N/A	N/A	N/A	14	6	36; 9.27	++
2009	Henry et al.	*	66.7%	47; 11.01	*	63.3%	44.3; 9.55	+

Year	Reference	Patient Group			Healthy Control Group			Study Quality
		Male	Female	Age (M; SD)	Male	Female	Age	
2009	Chiavarino et al.	7frontal/ 9parietal	0 frontal/ 1pariental	58	8	6	69	+
2007	Koenigs et al.	N/A	N/A	N/A	N/A	N/A	N/A	++
2006	Mitchell et al.	1	0	51	5	0	60	-
2006	Henry et al.	22	6	40.3; 13.6	22	9	39.8; 17.68	++
2006	Henry et al.	14	2	44.4; 13.36	*	*	*	++
2006	Beer et al.	unclear	unclear	unclear	unclear	unclear	unclear	+
2005	McDonald et al.	25	9	41	22	6	40.7; 11.8	++
2004	Shamay-Tsoory et al.	30 frontal/ 10 posterior	6 frontal / 5 posterior	35.44; 13.10	15	4	34.05; 15.81	++
2004	McDonald et al.	25	9	41; 12	22	12	36; 13	++
2004	Green et al.	*	*	*	*	*	*	+
2003	Hornak et al.	18	17	44; 15	*	*	*	++
2003	Kucharska-Pietura et al.	18 RH/ 17LH	12 RH/ 13 LH	N/A	24	26	N/A	++
2003	Milders et al.	10	7	30.5; 13.3	10	7	29.1; 12.1	++
2003	Charbonneau et al.	10 RH/10 LH	7 LH/5 RH	62.59; 5.98	11	5	61.75; 5.21	+
2002	Hopkins et al.	*	*	*	*	*	*	++
2002	Tranel et al.	3 RH/ 3LH	0 RH/ 1 LH	49.7	N/A	N/A	N/A	+
2001	Happe et al.	1	0	76	9	10	73	+
2000	Blair & Cipolotti	1	0	56	0	0	0	+
1998	Stone et al	N/A	N/A	N/A	N/A	N/A	N/A	-
1997	Jackson & Moffat	N/A	N/A	N/A	N/A	N/A	N/A	+

Note: N/A - information not available from the paper; *- information not available but authors present statistics suggesting no significant differences between groups.

Part II

Main research project

SOCIAL COGNITION AND FACIAL EMOTION PROCESSING IN PATIENTS WITH FOCAL FRONTAL LOBE DAMAGE

Matei Vladeanu

Supervised by Prof. Robin Morris, Dr. Lidia Yaguez, Dr. Reiner Sprengelmeyer and Prof. Keyoumars Ashkan

TABLE OF CONTENTS

1. Abstract

Most patients who have damage to areas of the frontal lobes experience a wide range of behaviour and personality changes such as impulsiveness (Winstanley et al, 2004), antisocial personality traits (Meyers et al, 1992) and poor socio-moral judgment (e.g. Blair and Cipolotti, 2000). Such deficits have in the past been linked to impairments in executive functioning (e.g. Tanji et al 2007). However, in order to adequately regulate social behaviour, one must first be able to understand other people's mental states (e.g., beliefs, emotions and intentions), abilities known as "social cognition." It has been proposed that individuals rely on facial appearance and facial emotion to make social decisions (Todorov, Baron & Oostenhof, 2008). Although the literature seems to consistently show that the impairments in basic emotion recognition and social cognition frequently occur together in patients with frontal brain damage, a theoretical model linking the two cognitive abilities remains elusive. Oosterhof & Todorov (2009) propose such a model whereby interpersonal contact is based on rapid evaluation of faces on two independent dimensions: trustworthiness and dominance (Oosterhof & Todorov, 2008; Todorov, Said, Engell, & Oosterhof, 2008). This study investigated the ability to evaluate face trustworthiness and dominance as well as the recognition accuracy of both simple and complex facial emotions in patients with focal frontal lobe damage. Neuropsychological measures have also been used to assess executive functioning.

Twenty patients with post surgical brain lesions in the frontal lobe were compared with twenty healthy controls matched for age, sex, education, and premorbid IQ on two measures of social cognition (trustworthiness/dominance task (Sprengelmeyer et al., in press) and Mind in the Eyes task, Baron-Cohen et al., 2001), a basic emotion recognition task (Ekman 60), and several neuropsychological tests currently used to assess executive functioning and facial processing abilities. Patients were impaired for trustworthiness and dominance judgements, but not for basic or complex emotion recognition (Mind in the Eyes Test). Patients also performed more poorly than controls on all neuropsychological measures of executive functioning, but were unimpaired at tasks involving non-emotional face processing. These findings suggest that

although basic emotion information extracted from facial expressions may be a used for trustworthiness and dominance judgements, further processing must occur in areas which are not involved with basic emotion processing. If those areas are affected, trustworthiness and dominance can be impaired whereas basic emotion recognition remains relatively unaffected.

2. Introduction

It is now widely accepted that people routinely extract a wide range of information from facial features such as gender, age, race and familiarity. In addition to this basic information, it has been suggested that socially relevant information may be conveyed by facial emotion, such as internal states, specific intentions towards others or particular behaviours expected from others (Ekman, 1997). Additionally, the ability to disguise or interfere with these expressions also plays an important role in modern social interaction (Okubo, Kobayashi and Ishikawa, 2012). Thus, accurate perception and interpretation of facial emotions is essential in order to guide social interaction. Currently, there is a general agreement there are six “basic” facial emotions which are universally recognised: anger, disgust, fear, happiness, sadness and surprise (e.g. Ekman, Sorenson and Friesen, 1969; Izard 1968; 1971).

Several studies reported that participants with focal damage to the frontal cortex (especially orbitofrontal areas) show an impairment in the recognition of negative emotions, whereas recognition of positive emotions is relatively less affected (e.g., Jackson & Moffat, 1997, Blair & Cipolotti, 2000; Hopkins, Dywan & Segalowitz, 2002; Kucharska-Pietura et al., 2003; Kemp, Berthel, Dufour, Despres, et al., 2013). Other studies conducted on participants with traumatic injuries to the frontal lobes (encompassing orbitofrontal, dorsolateral and ventromedial areas) report global impairment in the recognition of all basic emotions (e.g. Green, Turner and Thompson, 2004; Mitchell, Avny & Blair, 2006; Henry, Phillips, Beatty, McDonald et al., 2009; Williams and Wood, 2010; Callahan, Ueda, Sakata, Plamondon and Murai, 2011; Spikman, Timmerman, Milders, et al., 2012; Dal Monte, Krueger, Solomon, et al., 2013; Spikman, Milders, Visser-Keizer, et al., 2013). It has also been found that patients with lesions in both orbitofrontal and ventromedial areas seem to have difficulties expressing as well as perceiving emotions (e.g., Dethier et al, 2012).

However, difficulties in basic facial emotion recognition are not reported solely in patients with frontal lobe damage. For example, some studies found that the recognition of fear and anger is severely impaired in patients with bilateral amygdala damage whilst the recognition of other facial emotions seemed relatively unimpaired (e.g. Adolphs, Tranel, Damasio, et al., 1994, Calder et al.,

1996, Calder et al., 2001). A similar pattern of impairment is reported in patients with diffuse brain damage. For example Henry et al. (2009) reported that participants with multiple sclerosis (MS) had difficulties recognising facial expressions of fear and anger, but showed recognition performance similar to controls for surprise, sadness, disgust and happiness. This is probably because axonal damage in MS eventually results in disconnection of frontal-subcortical brain tracts involved in the processing of emotional signals (Ruffman, Henry, Livingstone, & Phillips, 2008).

Several studies suggested that impaired emotion recognition also affects one's "social cognition" abilities. Social cognition is an umbrella term for several cognitive skills that allow an individual to form a representation of other people's mental states (e.g., beliefs, emotions and intentions). Some of these skills are employed to detect a wide range of complex emotions in others (such as jealousy or love) and empathise with them (e.g., experiencing a similar emotion in the absence of the original stimulation, triggered solely by the perceived emotion in others). Other social cognition skills allow an individual to think from another person's perspective (also known as forming a Theory of Mind - ToM; Frith and Frith, 2010). It is therefore reasonable to assume that impaired basic emotion recognition would disrupt some aspects of social cognition. For example, difficulties in detecting a basic emotion such as sadness would probably impair one's ability to empathise with the person who is displaying sadness. Indeed, significant difficulties with processing of complex social emotions (such as guilt), reduced empathy and impairments in theory of mind (ToM) have been frequently reported in participants with frontal lobe damage (for a review see Radice-Neumann, Zupan, Babbage and Willer, 2007; Mc Donald, 2013). There seems to be a consensus in the literature that patients with frontal brain lesions generally perform poorer than healthy controls on tasks involving social cognition and basic emotion recognition (e.g. Milders, Fuchs and Crawford, 2003; Hornak, Bramham, Rolls, et. al., 2003; McDonald and Flanagan, 2004; Shamay-Tsoory, Tomer, Goldsher, et al., 2004; Henry, Phillips, Crawford, et al., 2006; Mitchell, Anvy and Blair, 2006; Spikman, Timmerman, Milders, Veenstra and van der Naalt, 2012; Njomboro, Humphreys and Deb, 2014).

Therefore, it has been proposed that in order to make sense of social behaviour, one must be able to accurately perceive and interpret social cues such as emotional expressions (facial, vocal or general body language), as well as correctly infer others' perspectives, intents, beliefs, emotional states (social cognition). The majority of studies published so far have focused on assessing social cognition through tasks require participants to infer the subtle emotional states, intentions and beliefs of characters depicted in short stories, cartoons or human actors from still images or video clips (e.g. Stone, Baron-Cohen and Knight, 1998; McDonald et al., 2002; Samson, Apperly, Chiavarino and Humphreys, 2004; Ehrle, Henry, Pesa & Bakchine, 2011). Although the studies seem to consistently show that the impairments in basic emotion recognition and social cognition (as measured by the task mentioned before) frequently occur together, a theoretical model linking the two cognitive abilities remains elusive. Oosterhof & Todorov (2009) propose such a model based on their observations that social decisions seem based on the information conveyed from basic facial emotions and found that negatively valenced faces (e.g. angry, sad, fearful) are generally judged as less approachable and trustworthy than happy faces. Other studies showed that these judgements are made very fast, between 39 and 100ms (Bar, Neta and Linz, 2006, Willis and Todorov, 2006; Todorov, et al., 2008).

This research prompted Todorov and his colleagues to propose a data driven model of interpersonal contact based on rapid evaluation of faces on two independent dimensions: trustworthiness and dominance (Oosterhof & Todorov, 2008; Todorov, Said, Engell, & Oosterhof, 2008). They argue that trustworthiness evaluation is simply the expression of an adaptive mechanism which signals whether the person should be avoided or approached. Conversely, dominance evaluation is based on the facial cues which signal physical strength. Taken together, the two dimensions could provide enough information to accurately infer harmful intentions or the ability to cause harm. Todorov et al, propose that recognition of trustworthy and dominance is correlated with happiness, disgust and anger (see Figure 1 below).

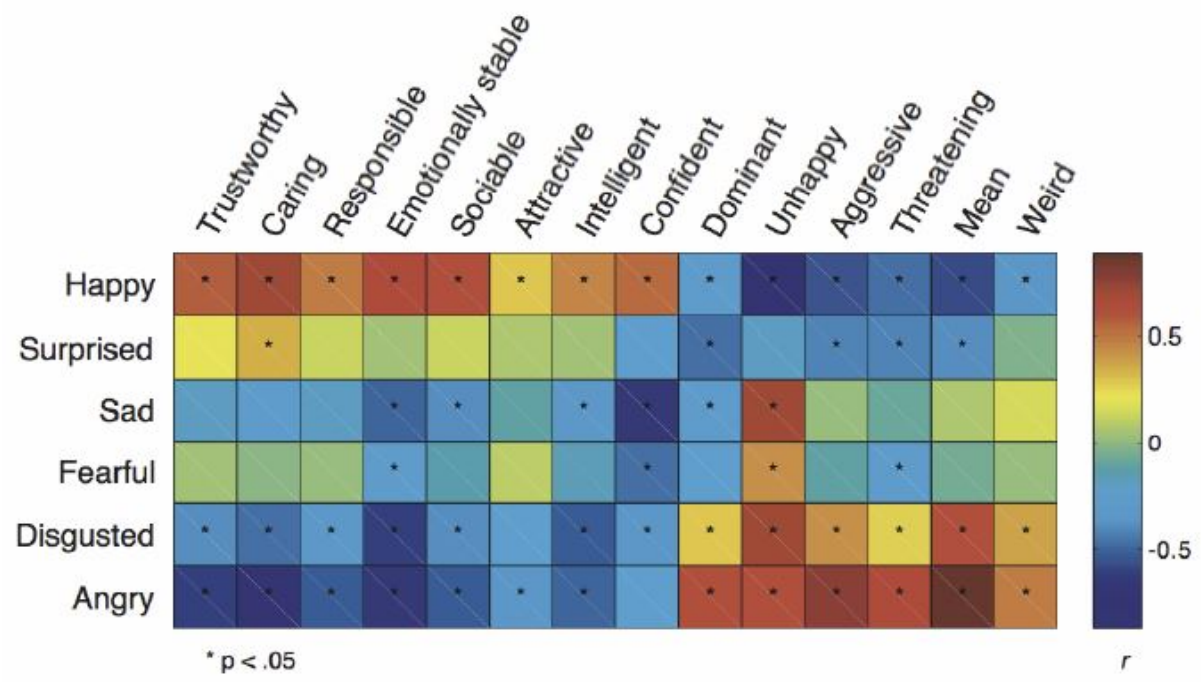


Figure 1. Correlations of trait dimensions with basic emotions (in Todorov, Fiske & Prentice. Social Neuroscience: Toward Understanding the Underpinnings of the Social Mind. Oxford University Press).

If successful interpersonal contact is driven by the ability to accurately perceive and interpret facial emotions, changes in facial emotion recognition abilities would also impact on people's ability to make accurate trustworthy and dominance judgements. However, mixed results are often reported in the literature. On the one hand, several studies have reported impairments in both social cognition and basic emotion recognition in participants with frontal brain lesions (e.g. Blair & Cipolotti, 2000; Milders et al., 2003; Hornak, Bramham, Rolls, Morris et al, 2003; McDonald et al., 2004; Shamay-Tsoory et al., Henry et al., 2006; Mitchell et al., 2006; Spikman et al., 2012; Njomboro, et al., 2014). On the other hand, some studies reported deficits in social cognition but relatively intact emotion recognition. For example, Adolphs, Tranel, & Damasio, (1998) suggested that participants with lesions to the orbitofrontal cortex and amygdala judged unfamiliar individuals as more approachable and trustworthy than healthy controls. Other studies report impaired social behaviour regulation in patients with orbitofrontal lesions (e.g. inappropriate disclosures to strangers), but intact basic emotional expression recognition (e.g. Beer, Heerey, Keltner, Scabini, & Knight, 2003). These results seem to suggest that the ability to

accurately recognise and classify basic facial emotion and the ability to use this information to guide social behaviour may be functionally dissociable.

More recently, Willis, Palermo, Burke, McGrillen, & Miller (2010) also showed that patients with orbitofrontal cortex damage rated faces showing negative emotion as significantly more approachable than healthy controls. Of note, this pattern of responses was not found in patients with frontal lobe lesions but without orbitofrontal damage. Additionally, Willis et al. (2010) found no differences in the ratings of approachability for faces displaying positive emotions in patients with orbitofrontal lesions. These patients showed unimpaired basic facial emotion recognition abilities, thereby suggesting that only approachability judgements were impaired. Thus the link between basic emotion recognition and judgements which drive interpersonal contact remains highly debated. This study aims to address this question by investigating both processes in patients with focal frontal lobe damage.

Arguably, complex social interactions may not be solely dependent on recognising the six basic emotions, although clearly these must form the basis of social cognition. The recognition of complex social emotions and mental states such as guilt, admiration, thoughtfulness or flirtatiousness have been explored by Baron-Cohen, Wheelwright, and Jolliffe (1997). They proposed that these complex mental and emotional states can also be inferred from the facial expressions, especially by carefully examining the region around the eyes, which seem to contain most of the information needed to make these social judgements. Previous research employed the Eyes in the Mind test proposed by Baron-Cohen et al, (2001) to investigate complex social emotion recognition in patients with frontal lobe damage and reported mixed results. On the one hand, Milders et al, (2003) who found that patients with severe TBI (with extensive bilateral damage to the frontal lobes) were able to detect subtle social emotions at levels comparable to controls. On the other hand, other studies reported impairments on the Mind in the Eyes Test in patients with smaller lesions in the ventromedial or dorsolateral prefrontal cortex (e.g. Henry et al, 2006; Geraci et al, 2010). This study aims investigate complex social emotion recognition, by using the Mind in the Eyes test in patients with focal lesions to the frontal lobes of the brain.

In the present study, patients with unilateral and bilateral surgical excisions in various regions of the frontal lobe of the brain were compared to healthy controls on a series of emotion recognition and social perception tasks as well as on neuropsychological measures widely used to assess executive functioning as face processing. This was done in order to find out i) whether patients with frontal lobe damage show impaired trustworthy and dominance judgements in comparison with healthy controls; ii) whether patients also show impaired basic and complex emotion recognition, and iii) whether impairment in executive functioning (as measured by several neuropsychological tests: Hayling Brixton, FAS, Trail making, DEX) is correlated with the performance in the social cognition and emotion recognition (simple or complex) tasks.

2. Methods

2. 1. Participants

2. 1. 1. Frontal cortex lesion group

Twenty patients (11 female, 9 male, Mean age=54.1 years, SD=15) were included in the study. They were under the care of the Joint Neuro-Oncology Clinic at King's College Hospital, London and had frontal cortical tumour resections at least 6 months prior to participating in the current study. The lesion site was ascertained by qualified neurosurgeons from MRI or CT scans and neuroradiogical reports. The lesions were defined anatomically[1] as: orbitofrontal (Brodmann areas 10, 11, 12 and 47); medial (Brodmann areas 8, 9, 24, 25, and 32) and dorsolateral (Brodmann areas 44, 45 and 46). These areas are depicted in Figure 2 below.

[1] These anatomical divisions have been previously used in the literature described in the introduction. Classifying lesions in those areas would facilitate the comparison between this study's results and others which looked at changes in facial emotion recognition and social cognition.

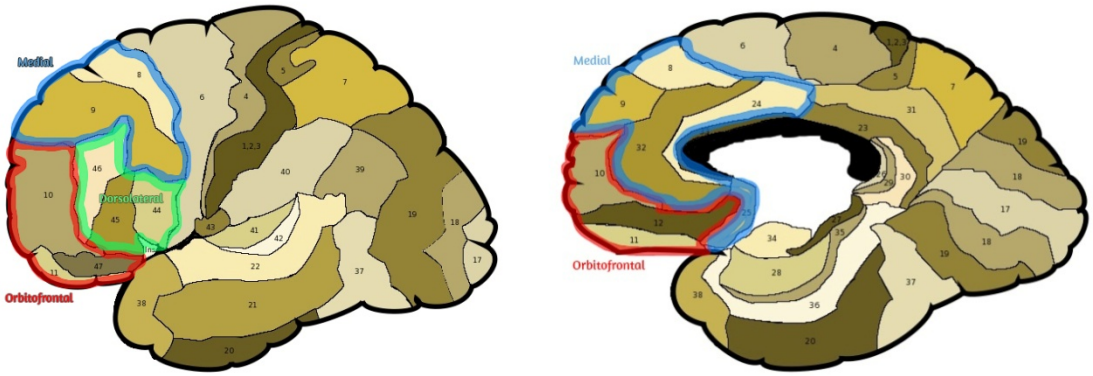


Figure 2. Brain maps showing main regions used to classify lesion sites, encompassing relevant Brodmann areas (Medial: 8, 9, 24, 25, 32; Dorsolateral: 44, 45 46; Orbitofrontal: 10, 11, 12, 47).

Lesion data are summarised in Table 1. There was an approximately half split in terms of left versus right hemisphere lesions, with 11 left and 9 right, and a further one patient with a bilateral lesions. Nine patients had lesions located in the medial areas of the frontal lobe, six in the dorsolateral areas and one in the orbitofrontal areas. Three had extensive lesions covering both orbitofrontal and medial areas.

Participant	Sex	Laterality	Lesion Location			Tumour Classification
			Orbito-frontal	Medial	Dorso-lateral	
1	M	L		X		Oligodendroglioma grade II
2	F	L	X			Glioblastoma multiforme grade IV
3	M	L		X		Oligodendroglioma grade II
4	M	L			X	Anaplastic oligodendroglioma grade III
5	F	L			X	Atypical Meningioma grade II
6	M	L		X		Anaplastic oligodendroglioma grade III
7	M	R		X		Pleomorphic xanthoastrocytoma grade II
8	M	R		X		Atypical meningioma grade II
9	F	L			X	Atypical meningioma grade II
10	F	R		X		Anaplastic oligodendroma WHO grade III
11	F	B	X	X		Atypical meningioma grade II
12	F	L		X		Neurocytoma, grade II (WHO
13	F	R		X		Oligoastrocytoma grade III
14	F	R		X		Atypical Meningioma grade II
15	F	R	X	X		Rhabdoid meningioma with focal papilary pattern WHO grade III
16	F	L			X	Astrocytoma WHO Grade II
17	F	R			X	Anaplastic oligoastrocytoma WHO grade III
18	M	R		X		Glioblastoma Multiforme Grade IV
19	M	L			X	Oligodendroglioma grade II
20	M	L	X	X		Atypical Meningioma Grade II

Table 1. Summary of lesion sites and tumour classification for each participant in the frontal cortex lesion group.

Exclusion criteria included: damage outside the frontal cortex, a history of alcohol or drug dependence, psychiatric disorders, English as a second language, and an estimated full-scale premorbid intelligence quotient (IQ) below 70.

2. 1. 2. Healthy Control group

Twenty healthy control participants were group matched with the patients for gender ratio and approximate age (11 female, 9 male, Mean age=52.6 years, SD=16.8) and also pre-morbid IQ with the patient groups were recruited locally. They had no neurological and psychiatric history and also had English as their first language with IQ estimates above 70.

Ethical approval was obtained from the local NHS Research Ethics Committee. Both groups gave written informed consent. All participants were offered £10 for their participation.

2. 2. Measures

2. 2. 1. Neuropsychological measures and self-report questionnaires

Standardised neuropsychological measures were used to test intellectual and executive functioning. The *Test of Premorbid Functioning* (TOPF; Wechsler, 2011), a revised and updated version of the Wechsler Test of Adult Reading, provided an estimate of premorbid intellectual functioning. Executive functioning was tested using: the *Trail Making Test* (TMT; Army Individual Test Battery 1944) which measures temporal sequencing and mental flexibility; *Hayling Sentence completion test*, a measure of response inhibition; the *Brixton Test*, a measure of planning and set shifting (Burgess & Shallice, 1997); and the F-A-S a subtest of the Neurosensory Center Comprehensive Examination for Aphasia (NCCEA; Spreen & Benton, 1977), which is a measure of phonemic word fluency which taps into executive control over cognitive process such as selective attention, and mental set shifting.

For behavioural abnormality detection, the Dysexecutive Questionnaire (DEX; Wilson et al, 1996) was used, a 20-item standardized measure of behavioural difficulties associated with executive functioning such as impulsivity, inhibition control, monitoring, and planning. Depression, anxiety and irritability was measured using the Hospital Anxiety and Depression Scales - Snaith Irritability

Scale (HADS-SIS, Snaith et al. 1978; Zigmond & Snaith, 1983), a 22-item self report scale that generates ordinal data; seven of the items relate to anxiety (maximum score of 21), seven to depression (maximum score of 21) and eight to irritability (maximum score of 24).

The neuropsychological tests and questionnaires were administered in pen-and-paper format to all participants.

2. 2. 2. Experimental procedure to assess social cognition

a. Trustworthiness and Dominance task (Sprengelmeyer et. al., in press)

The faces used in this study were originally constructed by taking 500 non-famous faces from the Internet in a separate pilot study and asking non-clinical participants to rate them for trustworthiness and dominance (Sprengelmeyer et. al., in press). The 10% most trustworthy and 10% least trustworthy looking males and females were selected. These faces were then morphed together to create four average faces: two very trustworthy looking (one male, one female), and two untrustworthy looking (one male, one female). These are highlighted with red squares in Figure 3 (located on rows 2 and 9, columns 2 and 9). These trustworthy prototypes were then morphed on two 10 point continua (see Figure 3 below). This procedure was replicated to create stimuli for the dominance task.

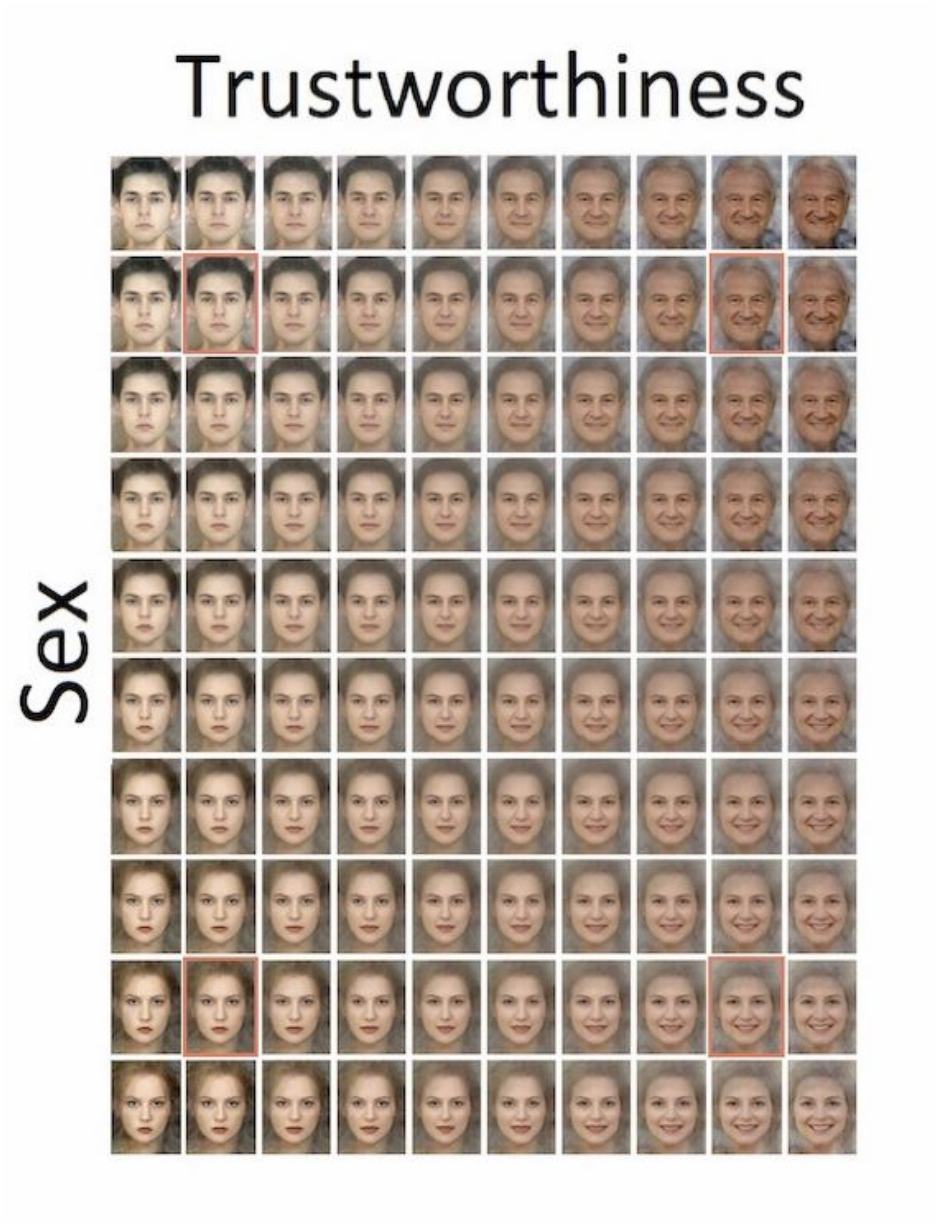


Figure 3. Examples of stimuli design. Four faces (two male, two female) were morphed on two 10-point continua (Trustworthiness and Sex), resulting in 100 faces.

To assess the participants' ability to make social judgments about trustworthiness and dominance, they were presented with four separate blocks of 40 trials. In each trial participants were presented with a single face and asked to make one of four different judgements: i) trustworthiness ii) trustworthiness sex control condition - femininity iii) dominance and iv) dominance sex control condition - femininity. The control conditions help distinguish between deficits of trustworthiness and dominance, and impaired general face processing. For the trustworthy/dominance tasks 40 stimuli were selected including all ten levels of trustworthy/dominance across faces taken

from the 2nd, 4th, 7th and 9th rows across the sex morphing. For the sex control tasks 40 stimuli were selected including all ten levels sex across faces taken from the 2nd, 4th, 7th and 9th rows across the trustworthy/dominance morphing. This gives 40 faces for each of the four tasks (trustworthiness, trustworthiness control, dominance, dominance control), providing a total of 160 stimuli. Each of the faces presented has to be rated individually by participants on a 7 point Likert scale for trustworthiness, dominance or femininity (control task), depending on the block (see Figure 4).

Each of the four tasks was presented in separate trial blocks, with the stimuli in each task randomized and presented sequentially on a computer screen. Block order was consistent across all participants: trustworthiness, trustworthiness sex control, dominance, dominance sex control. Each face was presented until the participant responded by pressing the keys 1 to 7 to indicate their choice. This was followed by a white blank image lasting one second until the next trial. There was no time limit for each trial, but participants were encouraged to make their decision as quickly and "instinctively" as they could. Following a response the participants could not revisit their answers and change their rating.

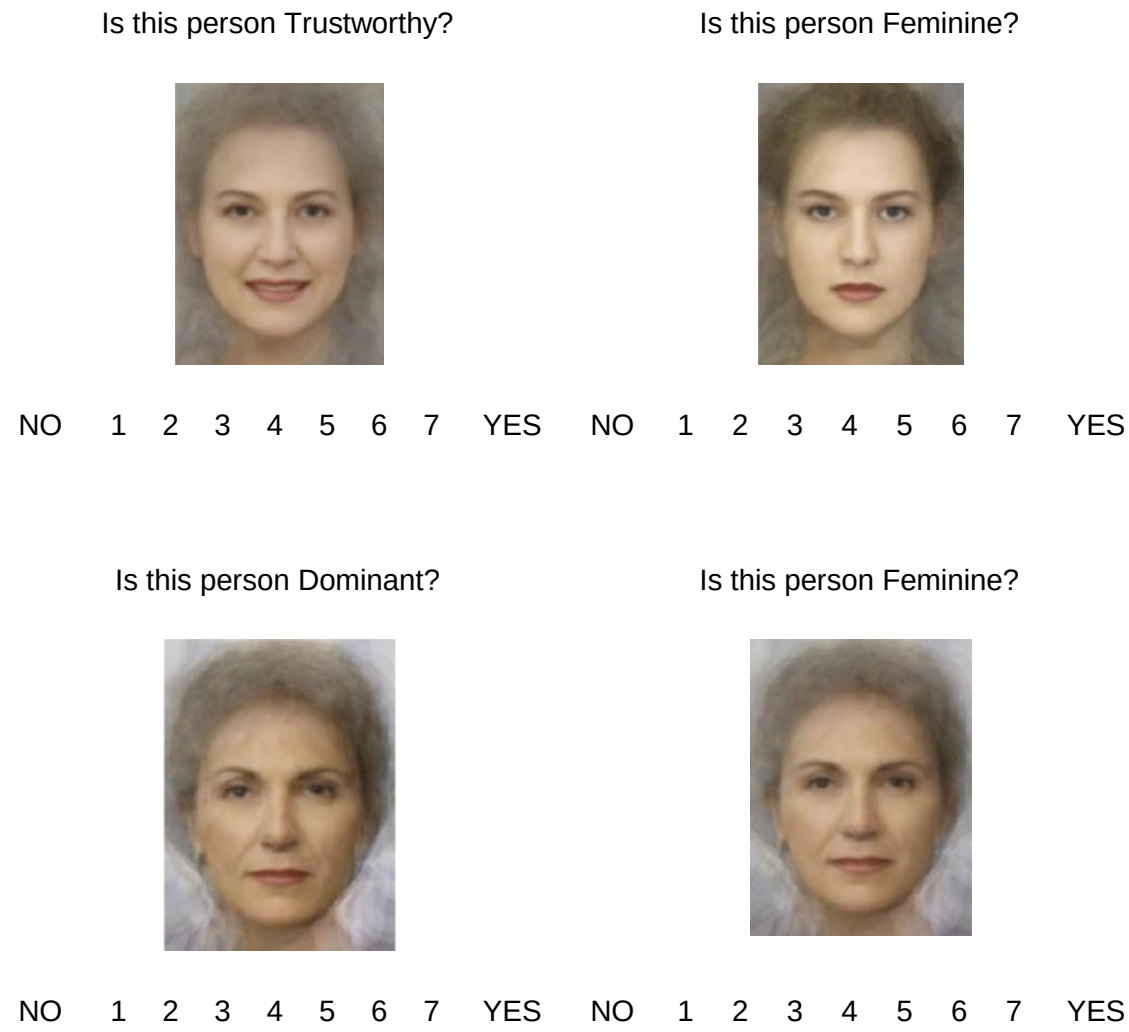


Figure 4. Example stimuli for the Trustworthy and Dominance task together with the control task (femininity/masculinity)

b. Revised complex social emotion recognition test, "Mind in the Eyes Test" (Baron-Cohen et al., 2001)

In this task, the participants have to judge the emotions suggested by 36 photographs of the eyes of human actors, displaying complex social emotions or mental states *(panicked, playful, upset, desire, insisting, worried, fantasising, uneasy, despondent, preoccupied, cautious, regretful, sceptical, anticipating, accusing, contemplative, thoughtful, doubtful, decisive, tentative, friendly, fantasising, preoccupied, defiant, interested, hostile, cautions, pensive, interested, reflective, flirtatious, confident, serious, concerned, distrustful, nervous, suspicious*). For each stimulus there is a choice of four words describing the emotion displayed, one of which is the correct one (see Figure 5). For this study, the material was presented on a computer and the

participants responded by mouse clicking their chosen word. Similarly to the previous task, there was a one second blank inter stimulus interval between two consecutive stimuli and with no revisiting of answers.

Playful **Comforting** **Irritated** **Bored**

Joking **Flustered** **Desire** **Convinced**

Terrified **Upset** **Arrogant** **Annoyed**

Joking **Insisting** **Amused** **Relaxed**

Figure 5. An example of the complex emotion recognition test (Baron-Cohen et al., 2001). Only one word correctly describes the emotion displayed.

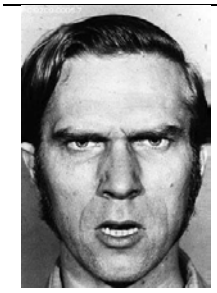
This test showed good cross cultural reliability in both clinical and non-clinical populations (e.g. Fernandez-Abascal, Cabello, Fernandez-Berrocal, and Baron-Cohen, 2013; Hallerback, Lugnegard, Hjarthag, and Gillberg, 2009; Yildirim, Kasar, Guduk, Ates, et al., 2011; Rojas, Serrano, Dillon, Bartoloni, et al., 2011; Prevost, Carrier, Chowne, Zelkowitzet al., 2014).

c. Ekman 60 faces test (Ekman and Friesen, 1976)

This task's purpose was to measure the accuracy of participant's facial emotional recognition concerning primary facial emotions. Photographs of the

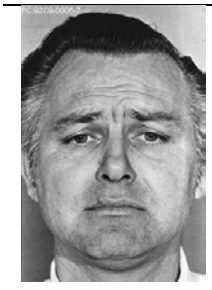
faces of 10 people (6 female, 4 male) were taken from the Ekman and Friesen (1976) series. For each face, there were poses corresponding to each of 6 emotions (happiness, surprise, fear, sadness, disgust, and anger), giving a total of 60 photographs (see Figure 6 for example stimuli). These were shown on a computer screen one at a time in a random order, and the participants were be asked to decide which of the emotion names (happiness, surprise, fear, sadness, disgust, or anger) best described the facial expression shown. There was a one second blank inter-stimulus interval between trials, no time limit for this task and no possibility to revisit answers.

Happiness Surprise Fear Sadness Disgust Anger



Happiness Surprise Fear Sadness Disgust Anger

Happiness Surprise Fear Sadness Disgust Anger



Happiness Surprise Fear Sadness Disgust Anger

Figure 6. Examples of the stimuli and response choices in the Ekman 60 face test. The face is shown, together with the six verbally presented choices.

d. Benton Facial Recognition Test (BFRT).

The Short Form of the BFRT (Benton, Hamsher, Varney and Spreen, 1983) was administered. This test consists of 13 items. For each item, participants are presented with an unfamiliar target face (always presented in a frontal pose) and an array of 6 faces presented simultaneously with the target face (see Figure 7).

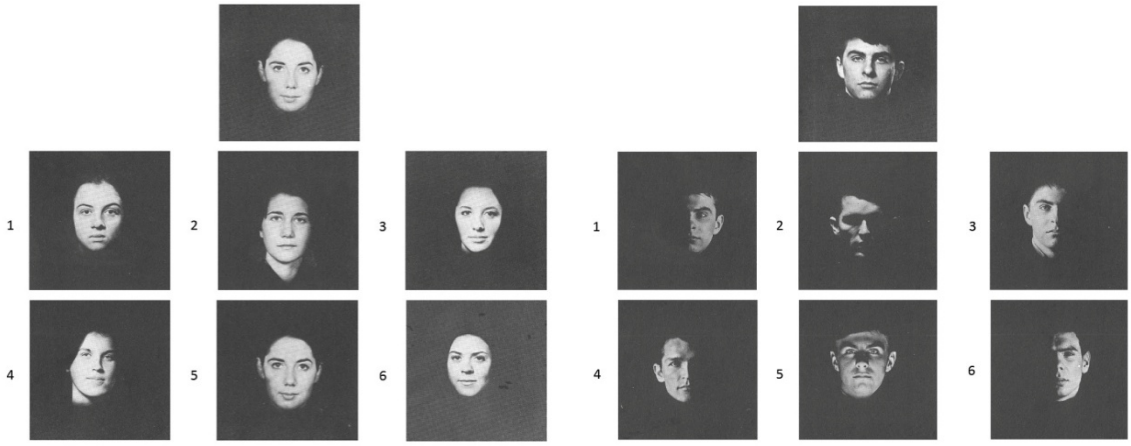


Figure 7. Example stimuli for the BFRT conditions one and two. On the left the target face at the top has one match in the array below. On the right, the target face at the top can be matched with three of the six faces presented in the array below, but these are shown in different viewpoints and lighting conditions.

The participants are asked to identify the target face in this array in three conditions of increasing difficulty. In the first condition the participants have to match the target face with an identical photograph among five distractors. In the second condition they have to match the target face with three photos of the target taken from different angles which are presented together with three distractors. Finally, in the third and most difficult condition, they are asked to match the target face with three photos of the target taken under different lighting conditions (again these are presented together with three distractors). This task was also presented on a computer screen. The target face was presented at the top of the screen and the array of responses was presented immediately below it (similarly to the paper version of the test). The participants

were instructed to make their choice by selecting the responses with the mouse pointer.

3. Results

3. 1. Demographic and neuropsychological variables

The descriptive statistics summarised in Table 2. These were analysed using independent t tests to compare the control and patient groups. Sex ratios between groups were perfectly matched and age, education and pre-morbid IQ showed good group matching. The patients scored significantly higher than controls on the Dysexecutive Questionnaire, HADS anxiety, depression and irritability. The patients performed significantly worse than the controls across all of the neuropsychological test measures, except for on Trail Making A.

	Controls		Patients		Statistical comparison		
	Mean	**SD**	**Mean**	**SD**	**t**	**p**	**d**
Age	52.6	16.8	54.1	15.0	-.3	.768	0.097
Years of education	12.7	1.8	12.9	2.0	-.3	.745	0.097
TOPF	104.8	7.8	106.5	8.8	-.6	.533	0.195
DEX	2.2	2.7	33.7	9.4	-14.4	< .001	4.672
HADS-SIS: Anxiety	3.7	3.1	8.3	3.6	-4.3	< .001	1.395
HADS-SIS: Depression	1.3	1.7	6.1	3.6	-5.3	< .001	1.720
HADS-SIS: Irritability	1.0	1.1	9.5	4.9	-7.5	< .001	2.433
Trail making: Trial A time (s)	30.7	7.5	38.3	16.0	-1.9	.063	0.616
Trail making: Trial B time (s)	67.5	17.3	90.1	43.6	-2.2	.038	0.714
Trail making test: B-A time	36.8	10.5	51.8	29.5	-2.1	.039	0.681
FAS scaled scores	10.7	2.4	6.2	2.5	5.9	< .001	1.914
Category fluency scaled scores	10.7	2.4	5.8	2.9	5.8	< .001	1.882
Hayling overall scaled score	7.2	1.1	4.5	1.1	7.5	< .001	2.433
Brixton scaled score	6.8	1.3	4.3	2.0	4.7	< .001	1.525

* Note, df = 38 for all analyses.

Table 2: Demographic and neuropsychological variables, with statistical comparison between control (n = 20; female 11) and patient (n= 20; female 11) groups. t tests show statistical group comparisons.

3. 2. Facial processing analysis strategy

Initial analyses used ANCOVAs to compare performance on each of the face processing tasks, making three separate between-subjects comparisons: controls vs. patients, left vs. right hemisphere lesions, medial vs. dorsolateral lesions. For each task the experimental or test manipulations were included as a within-subject factor.

The between-subject group factor varied between three different analyses. First, patients were compared with controls; second, unilateral left (LH, N = 11) were compared with right hemisphere lesions (RH, N = 8) (this excluded the one bilateral lesion patient); third, medial lesions (N = 12) were compared with dorsolateral lesions (N = 6) (here two patients had lesions in multiple sites and were excluded from these analyses).

The within-subject factor for the trustworthiness and dominance tasks there were 10 levels (low trustworthiness/dominance through to high trustworthiness/dominance). For the Ekman 60 task there were six levels (anger, disgust, fear, happiness, sadness and surprise).

In all of the analyses the ANCOVA method was used to control for anxiety, depression and irritability, as patients scored significantly higher than controls on all three of these variables (see Table 2) and they were deemed as possibly influencing facial perceptual responding.

To address the hypotheses of this study multiple correlation coefficients were calculated across the ten experimental conditions for the trustworthiness and dominance tasks (including the sex control tasks). With this measure a stronger correlation indicates that ratings were related across the ten experimental conditions (i.e., responses were more accurate), whereas a weaker correlation indicates that ratings were less related or unrelated (i.e., responses were more random). For controls it is expected that responses will be highly correlated, whereas for patients there is typically no correlation across the ratings. These correlation coefficients were compared using independent measures t tests and were also correlated with accuracy for the processing of the six basic emotions (patients and controls separately).

Full descriptive statistics are presented for all analyses in the Appendices. Line graphs, with error bars showing ± 1 standard error, are presented to aid in the interpretation of all significant findings.

3. 3. Trustworthiness: Group comparisons

3. 3. 1. Controls versus patients

Full descriptive statistics are given in Appendix 1 and are presented graphically in Figure 8. Mauchley's test of sphericity was significant (W = .017, $\chi 2$ (44) = 130.3, p < .001), therefore the Greenhouse-Geisser correction was applied to all relevant analyses.

The main effect of level was significant (F (4.4, 152.8) = 11.9, p < .001, partial η^2 = .253) showing that ratings of trustworthiness increase as level of facial trustworthiness increases, with no main effect of group (F (1, 35) = 1.0, p = .332, partial η^2 = .027). The interaction between level and group was significant (F (4.4, 152.8) = 4.5, p < .001, partial $\eta 2$ = .253; see Figure 8). The significant interaction was broken down using a polynomial trend analysis for each group separately to determine how their trustworthiness ratings changed across the ten levels of increasing trustworthiness. For the controls there is a significant linear increase in trustworthiness ratings as the level of trustworthiness within a face increases (F (1, 16) = 182.2, p < .001, partial η^2 = .919), whereas for the patients there is no significant change (F (1, 16) = 3.0, p = .101, partial η^2 = .159).

None of the HADS-SIS control variables were significant confounds (anxiety: F (1, 35) = 1.6, p = .215, partial η^2 = .043; depression: F (1, 35) = 0.1, p = .856, partial η^2 = .001; irritability: F (1, 35) = 0.1, p = .834, partial η^2 = .001).

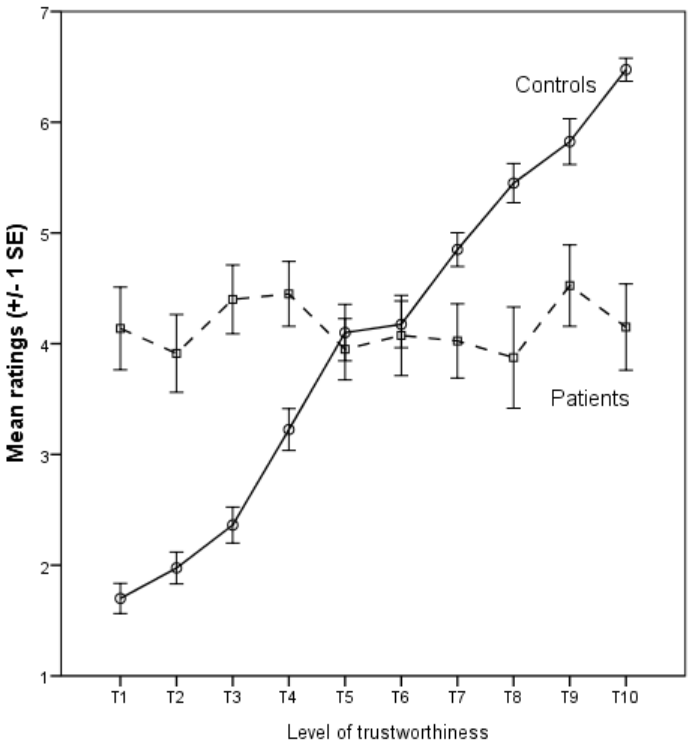


Figure 8. Mean trustworthiness ratings (± 1 SE) for control and patient participants as a function of trustworthiness level.

3. 3. 2. Left versus right hemisphere lesions

Full descriptive statistics are given in Appendix 2. Mauchley's test of sphericity was significant (W = .003, χ^2 (44) = 64.7, p = .037), therefore the Greenhouse-Geisser correction was applied to all relevant analyses.

The main effect of level was not significant (F (3.3, 46.4) = 1.7, p = .167, partial η^2 = .111), nor was the main effect of lesion laterality (F (1, 35) = 0.5, p = .506, partial η^2 = .032) or the interaction between level and lesion laterality (F (3.3, 46.4) = 0.7, p = .596, partial η^2 = .045).

The HADS-SIS control variables were not significant (anxiety: F (1, 35) = 0.1, p = .724, partial η^2 = .009; depression: F (1, 35) = 0.1, p = .813, partial η^2 = .004; irritability: F (1, 35) = 0.1, p = .847, partial η^2 = .003).

3. 3. 3. Medial versus dorsolateral lesions

Full descriptive statistics are given in Appendix 3. Mauchley's test of sphericity was not significant (W = .002, χ^2 (44) = 59.3, p = .097.

The main effect of level was not significant (F (9, 117) = 1.6, p = .114, partial η^2 = .112), nor was the main effect of lesion location (F (1, 35) = 0.1, p = .978, partial η^2 = .000) or the interaction between level and lesion location (F (9, 117) = 0.5, p = .533, partial η^2 = .064).

There were no significant confounds (anxiety: F (1, 35) = 0.2, p = .682, partial η^2 = .013; depression: F (1, 35) = 0.4, p = .563, partial η^2 = .026; irritability: F (1, 35) = 0.6, p = .465, partial η^2 = .042).

3. 3. 4. Summary of analyses on the trustworthiness task results

When comparing control and patients, controls show the expected increase in trustworthiness ratings, whereas patients do not. There are no differences according to lesion laterality or site.

3. 4. Trustworthiness sex control task: Group comparisons

3. 4. 1. Controls versus patients

Full descriptive statistics are given in Appendix 4 and are presented graphically in Figure 9. Mauchley's test of sphericity was significant (W = .005, χ^2 (44) = 168.1, p < .001), therefore the Greenhouse-Geisser correction was applied to all relevant analyses.

The main effect of level was significant (F (3.4, 120.0) = 44.1, p < .001, partial η^2 = .558) showing that ratings of femininity increase as level of facial femininity increases. The main effect of group was significant (F (1, 35) = 9.5, p = .004, partial η^2 = .214) with femininity ratings higher for patients (M = 4.6, SE = .14)

than for controls (M = 3.9, SE = .14). The interaction between level and group was not significant (F (3.4, 120.0) = 1.4, p = .191, partial η^2 = .038).

HADS-SIS Anxiety was a significant control variable (F (1, 35) = 5.6, p = .024, partial η^2 = .137), but neither of the other HADS-SIS control variables were significant (depression: F (1, 35) = 2.1, p = .156, partial η^2 = .057; irritability: F (1, 35) = 1.9, p = .181, partial η^2 = .051).

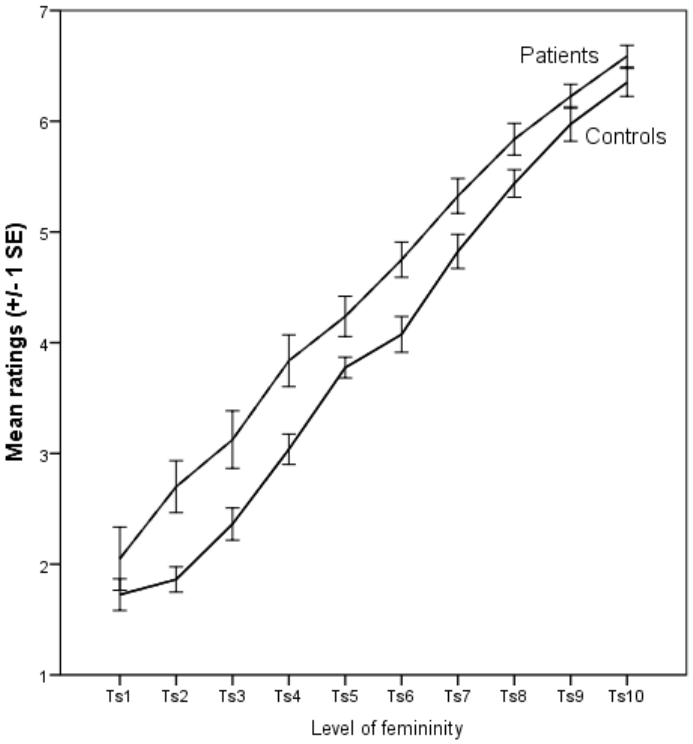


Figure 9. Estimated marginal mean femininity ratings (± 1 SE) for control and patient participants as a function of femininity level.

3. 4. 2. Left versus right hemisphere lesions

Full descriptive statistics are given in Appendix 5 and are presented graphically in Figure 10. Mauchley's test of sphericity was significant (W = .000, χ^2 (44) = 123.4, p < .001), therefore the Greenhouse-Geisser correction was applied to all relevant analyses.

The main effect of level was significant (F (2.4, 33.8) = 16.1, p < .001, partial η^2 = .534) showing increasing femininity ratings as level of facial femininity

increases. The main effect of lesion laterality was not significant (F (1, 35) = 9.7, p = .083, partial η^2 = .199), however the interaction between level and lesion laterality was (F (2.4, 33.8) = 2.7, p = .007, partial η^2 = .161). This was broken down using a polynomial trend analysis for each group separately. There was a significant linear increase in trustworthiness ratings for patients with left hemisphere lesions (F (1, 10) = 594.4, p < .001, partial η^2 = .969) and for patients with right hemisphere lesions (F (1, 7) = 30.0, p = .001, partial η^2 = .811). Inspection of Figure 10 shows that the interaction arises from a more marked linear increase in ratings for patients with left hemisphere lesions than for patients with right hemisphere lesions.

HADS-SIS Anxiety was a significant control variable (F (1, 35) = 7.1, p = .019, partial η^2 = .336), but neither of the others were s (depression: F (1, 35) = 1.6, p = .233, partial η^2 = .100; irritability: F (1, 35) = 0.9, p = .373, partial η^2 = .057).

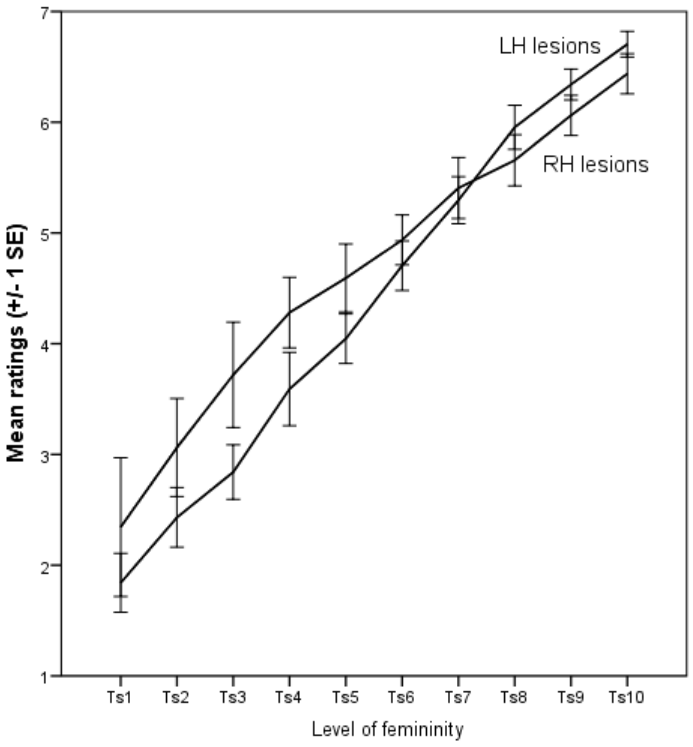


Figure 10. Estimated marginal mean femininity ratings (± 1 SE) for patient with left and right hemisphere lesions as a function of femininity level.

3. 4. 3. Medial versus dorsolateral lesions

Full descriptive statistics are given in Appendix 6. Mauchley's test of sphericity was significant (W = .000, χ^2 (44) = 123.8, p < .001), therefore the Greenhouse-Geisser correction was applied to all relevant analyses.

The main effect of level was significant (F (2.1, 27.7) = 9.6, p < .001, partial η^2 = .424) showing that ratings of femininity increase as level of facial femininity increases. The main effect of lesion site was not significant (F (1, 35) = 1.7, p = .221, partial η^2 = .113), nor was the interaction (F (2.4, 33.8) = 2.7, p = .007, partial η^2 = .161).

HADS-SIS Anxiety was a significant control variable (F (1, 35) = 6.2, p = .027, partial η^2 = .323), but neither of the other HADS-SIS control variables were significant confounds (depression: F (1, 35) = 1.7, p = .211, partial η^2 = .118; irritability: F (1, 35) = 4.1, p = .064, partial η^2 = .240).

3. 4. 4. Summary

Patients rate faces as more feminine than controls, regardless of the level of femininity within the face. The increase in rated femininity is more marked for patients with left hemisphere lesions than for patients with right hemisphere lesions; however there are no differences according to lesion site.

3. 5. Dominance: Group comparisons

3. 5. 1. Controls versus patients

Full descriptive statistics are given in Appendix 7 and are presented graphically in Figure 11. Mauchley's test of sphericity was significant (W = .093, χ2 (44) = 75.7, p = .002), therefore the Greenhouse-Geisser correction was applied to all relevant analyses.

The main effect of level was significant (F (6.1, 212.7) = 2.3, p = .019, partial η^2 = .060) showing that ratings of dominance increase as level of facial dominance increases. The main effect of group was not significant (F (1, 35) = 1.0, p = .329, partial η2 = .027). The interaction between level and group was significant (F (6.1, 212.7) = 21.5, p < .001, partial η2 = .381; see Figure 11). For controls there is a significant linear increase in dominance ratings as the level of dominance within a face increases (F (1, 16) = 172.2, p < .001, partial η^2 = .915). In contrast, for patients there is a significant linear decrease in dominance ratings (F (1, 16) = 10.8, p = .005, partial η^2 = .403).

None of the HADS-SIS variables were significant confounds (anxiety: F (1, 35) = 0.2, p = .649, partial η^2 = .006; depression: F (1, 35) = 0.1, p = .877, partial η^2 = .001; irritability: F (1, 35) = 1.3, p = .264, partial η^2 = .035).

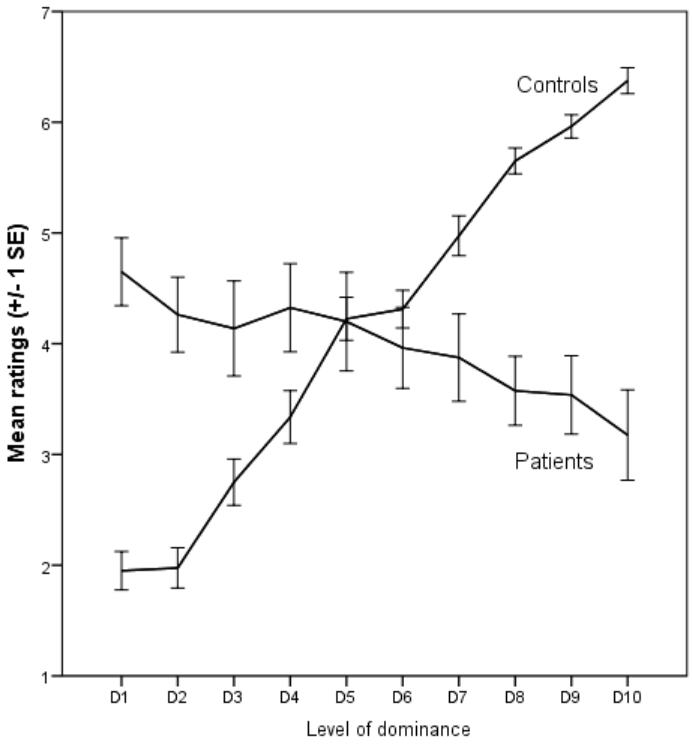


Figure 11. Mean dominance ratings (± 1 SE) for control and patient participants as a function of dominance level.

3. 5. 2. Left versus right hemisphere lesions

Full descriptive statistics are given in Appendix 8. Mauchley's test of sphericity was not significant (W = .014, χ^2 (44) = 45.8, p = .471).

The main effect of level was significant ($F (9, 126) = 2.5$, $p = .011$, partial $\eta^2 = .152$) showing that ratings of dominance increase as level of facial dominance increases. The main effect of lesion laterality was not significant ($F (1, 14) = 0.1$, $p = .959$, partial $\eta^2 = .000$), nor was the interaction ($F (9, 126) = 0.7$, $p = .738$, partial $\eta^2 = .045$).

None of the HADS-SIS control variables were significant (anxiety: $F (1, 14) = 0.2$, $p = .693$, partial $\eta^2 = .011$; depression: $F (1, 14) = 0.1$, $p = .722$, partial $\eta^2 = .009$; irritability: $F (1, 14) = 1.2$, $p = .297$, partial $\eta^2 = .077$).

3. 5. 3. Medial versus dorsolateral lesions

Full descriptive statistics are given in Appendix 9. Mauchley's test of sphericity was not significant ($W = .003$, $\chi^2 (44) = 55.5$, $p = .168$).

The main effect of level was significant ($F (9, 117) = 3.8$, $p < .001$, partial $\eta^2 = .225$) showing that ratings of dominance increase as level of facial dominance increases. The main effect of lesion site was not significant ($F (1, 13) = 0.1$, $p = .896$, partial $\eta^2 = .001$), nor was the interaction between level and lesion site ($F (9, 117) = 1.7$, $p = .088$, partial $\eta^2 = .118$).

The HADS-SIS variables were not significant confounds (anxiety: $F (1, 13) = 0.5$, $p = .483$, partial $\eta^2 = .039$; depression: $F (1, 13) = 0.7$, $p = .698$, partial $\eta^2 = .012$; irritability: $F (1, 13) = 1.2$, $p = .298$, partial $\eta^2 = .083$).

3. 5. 4. Summary

When comparing control and patients, controls show the expected increase in dominance ratings, whereas patients show the opposite pattern of decreasing dominance ratings. There are no differences according to lesion laterality or lesion site.

3. 6. Dominance sex control task: Group comparisons

3. 6. 1. Controls versus patients

Full descriptive statistics are given in Appendix 10. Mauchley's test of sphericity was significant (W = .026, χ^2 (44) = 116.2, p < .001), therefore the Greenhouse-Geisser correction was applied to all relevant analyses.

The main effect of level was significant (F (4.2, 146.5) = 29.3, p < .001, partial η^2 = .456) showing that ratings of femininity increase as level of facial femininity increases. The main effect of group was not significant (F (1, 35) = 0.8, p = .371, partial η^2 = .023). The interaction between level and group was not significant (F (4.2, 146.5) = 0.5, p = .851, partial η^2 = .015).

None of the HADS-SIS control variables were significant (anxiety: F (1, 35) = 0.1, p = .731, partial η^2 = .003; depression: F (1, 35) = 0.1, p = .893, partial η^2 = .001; irritability: F (1, 35) = 2.0, p = .170, partial η^2 = .053).

3. 6. 2. Left versus right hemisphere lesions

Full descriptive statistics are given in Appendix 11. Mauchley's test of sphericity was significant (W = .000, χ^2 (44) = 83.3, p < .001), therefore the Greenhouse-Geisser correction was applied to all relevant analyses.

The main effect of level was significant (F (3.1, 43.4) = 7.6, p < .001, partial η^2 = .352) showing that ratings of femininity increase as level of facial femininity increases. The main effect of lesion laterality was not significant (F (1, 14) = 0.3, p = .577, partial η^2 = .023), nor was the interaction (F (3.1, 43.4) = 1.2, p = .342, partial η^2 = .076).

The HADS-SIS variables were not significant confounds (anxiety: F (1, 14) = 0.7, p = .430, partial η^2 = .045; depression: F (1, 14) = 0.1, p = .877, partial η^2 = .002; irritability: F (1, 14) = 2.2, p = .156, partial η^2 = .138).

3. 6. 3. Medial versus dorsolateral lesions

Full descriptive statistics are given in Appendix 12. Mauchley's test of sphericity was significant (W = .000, χ^2 (44) = 86.4, p < .001), therefore the Greenhouse-Geisser correction was applied to all relevant analyses.

The main effect of level was significant (F (2.3, 36.3) = 6.6, p < .001, partial η^2 = .337) showing that ratings of femininity increase as level of facial femininity increases. The main effect of lesion site was not significant (F (1, 13) = 0.5, p = .463, partial η^2 = .042), nor was the interaction between level and lesion site (F (2.3, 36.3) = 0.9, p = .425, partial η^2 = .068).

None of the HADS-SIS variables were significant confounds (anxiety: F (1, 13) = 0.5, p = .508, partial η^2 = .034; depression: F (1, 13) = 0.1, p = .852, partial η^2 = .003; irritability: F (1, 13) = 0.5, p = .490, partial η^2 = .037).

3. 6. 4. Summary

Femininity ratings increase with increasing levels of facial femininity, but this does not vary between patients and controls. There were no differences according to lesion laterality or site.

3. 7. Ekman 60 task: Group comparisons

3. 7. 1. Controls versus patients

Full descriptive statistics are given in Appendix 13. Mauchley's test of sphericity was significant (W = .266, χ^2 (14) = 43.8, p < .001), therefore the Greenhouse-Geisser correction was applied to all relevant analyses.

The main effect of emotion was significant (F (3.5, 121.0) = 3.4, p = .006, partial η^2 = .088). For the descriptive statistics for this main effect, see Table 3. Anger was recognised with significantly less accuracy than disgust (p = .009),

happiness (p < .001), sadness (p < .001) and surprise (p < .001), but not fear (p = .926). Disgust was recognised with significantly greater accuracy than fear (p =.002), with less accuracy than happiness (p < .001) and surprise (p < .001), but not differently from sadness (p = .071). Fear was recognised with significantly less accuracy than happiness (p < .001), sadness (p < .001) and surprise (p < .001). Happiness was recognised with significantly greater accuracy than sadness (p < .001) and surprise (p < .001). Sadness was recognised with significantly greater accuracy than surprise (p = .003).

Emotion	Mean	SE
Anger	7.4	.3
Disgust	8.2	.2
Fear	7.4	.3
Happiness	10.0	.0
Sadness	8.8	.2
Surprise	9.4	.1

Table 3. Descriptive statistics for the main effect of emotion on the Ekman 60 task.

The main effect of group was not significant (F (1, 35) = 0.1, p = .894, partial η2 = .001), nor was the interaction between emotion and group was not significant (F (3.5, 121.0) = 0.6, p = .538, partial η2 = .021).

HADS-SIS Irritability was a significant control variable (F (1, 35) = 9.7, p = .004, partial η^2 = .217), but neither of the other HADS-SIS control variables were significant confounds (anxiety: F (1, 35) = 3.1, p = .087, partial η^2 = .081; depression: F (1, 35) = 0.8, p = .371, partial η^2 = .023).

3. 7. 2. Left versus right hemisphere lesions

Full descriptive statistics are given in Appendix 14. Mauchley's test of sphericity was significant (W = .047, χ^2 (14) = 37.0, p = .001), therefore the Greenhouse-Geisser correction was applied to all relevant analyses.

The main effect of emotion was significant (F (2.3, 39.1) = 2.6, p = .034, partial η^2 = .156). For the descriptive statistics for this main effect, see Table 4. Anger was recognised with significantly less accuracy than disgust (p = .031), happiness (p < .001), sadness (p = .001) and surprise (p < .001), but not fear (p = .336). Disgust was recognised with significantly greater accuracy than fear (p =.005), with less accuracy than happiness (p < .001) and sadness (p = .014) and surprise (p = .001). Fear was recognised with significantly less accuracy than happiness (p < .001), sadness (p < .001) and surprise (p < .001). Happiness was recognised with significantly greater accuracy than sadness (p < .001) and surprise (p = .018). Sadness was recognised with significantly greater accuracy than surprise (p = .007).

Emotion	Mean	SE
Anger	6.6	.4
Disgust	7.6	.4
Fear	6.2	.5
Happiness	10.0	.0
Sadness	8.7	.2
Surprise	9.6	.1

Table 4: Descriptive statistics for the main effect of emotion on the Ekman 60 task.

The main effect of lesion laterality was not significant (F (1, 14) = 0.1, p = .880, partial η2 = .002), nor was the interaction between emotion and lesion laterality (F (2.3, 39.1) = 0.4, p = .875, partial η2 = .025).

HADS-SIS Anxiety was a significant control variable (F (1, 14) = 5.6, p = .033, partial η^2 = .285), as was HADS-SIS Irritability (F (1, 14) = 10.8, p = .005, partial η^2 = .435), but HADS-SIS Depression was not (F (1, 14) = 1.0, p = .341, partial η^2 = .065).

3. 7. 3. Medial versus dorsolateral lesions

Full descriptive statistics are given in Appendix 15. Mauchley's test of sphericity was significant (W = .048, χ^2 (14) = 33.8, p = .003), therefore the Greenhouse-Geisser correction was applied to all relevant analyses.

The main effect of emotion was not significant (F (2.6, 34.2) = 1.6, p = .218, partial η^2 = .108), nor was the main effect of lesion site (F (1, 13) = 0.3, p = .601, partial η2 = .022), or the interaction between emotion and lesion site (F (2.6, 34.2) = 0.4, p = .863, partial η2 = .028).

HADS-SIS Anxiety was a significant control variable (F (1, 13) = 5.6, p = .034, partial η^2 = .302), as was HADS-SIS Irritability (F (1, 13) = 15.8, p = .002, partial η^2 = .549), but HADS-SIS Depression was not (F (1, 13) = 0.5, p = .500, partial η^2 = .036).

3. 7. 4. Summary

The emotions are recognised with differing levels of accuracy, but this does not differ between control and patient participants or according to lesion laterality or site.

3. 8. Mind in the Eyes task: Group comparisons

3. 8. 1. Controls versus patients

Descriptive statistics are presented in Appendix 16.

The main effect of group was not significant (F (1, 35) = 3.7, p = .063, partial η^2 = .095). HADS-SIS Irritability was a significant control variable (F (1, 35) = 4.8, p = .035, partial η^2 = .120), but neither of the other HADS-SIS control variables were significant (anxiety: F (1, 35) = 1.3, p = .270, partial η^2 = .035; depression: F (1, 35) = 0.3, p = .637, partial η^2 = .006).

3. 8. 2. Left versus right hemisphere lesions

Descriptive statistics are presented in Appendix 16.

The main effect of lesion laterality was not significant (F (1, 14) = 1.7, p = .212, partial η^2 = .109). None of the HADS-SIS control variables were significant (anxiety: F (1, 14) = 1.1, p = .320, partial η^2 = .070; depression: F (1, 14) = 0.3, p = .608, partial η^2 = .019; irritability: F (1, 14) = 0.6, p = .438, partial η^2 = .043).

3. 8. 3. Medial versus dorsolateral lesions

Descriptive statistics are presented in Appendix 16.

The main effect of lesion site was not significant (F (1, 13) = 0.9, p = .356, partial η^2 = .066). The HADS-SIS variables were not significant confounds (anxiety: F (1, 13) = 0.1, p = .787, partial η^2 = .006; depression: F (1, 13) = 0.1, p = .812, partial η^2 = .005; irritability: F (1, 13) = 2.4, p = .142, partial η^2 = .158).

3. 8. 4. Summary

Performance on the Mind in the Eyes Test did not differ according to group, lesion laterality or lesion site.

3. 9. Benton face recognition task: Group comparisons

3. 9. 1. Controls versus patients

Descriptive statistics are presented in Appendix 16.

The main effect of group was not significant (F (1, 35) = 0.1, p = .849, partial η^2 = .001). None of the HADS-SIS variables were significant confounds (anxiety: F

(1, 35) = 0.6, p = .440, partial η^2 = .017; depression: F (1, 35) = 0.8, p = .378, partial η^2 = .022; irritability: F (1, 35) = 0.4, p = .514, partial η^2 = .012).

3. 9. 2. Left versus right hemisphere lesions

Descriptive statistics are presented in Appendix 16.

The main effect of lesion laterality was not significant (F (1, 14) = 0.1, p = .731, partial η^2 = .009). The HADS-SIS control variables were not significant (anxiety: F (1, 14) = 0.1, p = .820, partial η^2 = .004; depression: F (1, 14) = 0.1, p = .791, partial η^2 = .005; irritability: F (1, 14) = 0.2, p = .641, partial η^2 = .016).

3. 9. 3. Medial versus dorsolateral lesions

Descriptive statistics are presented in Appendix 16.

The main effect of lesion site was not significant (F (1, 13) = 0.1, p = .834, partial η^2 = .004). None of the HADS-SIS variables were significant confounds (anxiety: F (1, 13) = 0.2, p = .642, partial η^2 = .017; depression: F (1, 13) = 0.1, p = .954, partial η^2 = .000; irritability: F (1, 13) = 0.1, p = .849, partial η^2 = .003).

3. 9. 4. Summary

Performance on the Emotion in the Eyes task did not differ according to group, lesion laterality or lesion site.

3. 10. Summary of all group comparison analyses

A summary of all analyses showing significant differences according to group (control vs. patient), lesion laterality (left hemisphere vs. right hemisphere) or lesion site (medial vs. dorsolateral) as shown in Table 5.

	Group	Lesion laterality	Lesion site
Trustworthiness	*Interaction* Controls: Increase in Trustworthiness Patients: No change	-	-
Trust: sex control	*Main effect* Patients > Controls	*Interaction* Increase greater for LH than RH lesions	-
Dominance	*Interaction* Controls: Increase in Dominance Patients: Decrease in Dominance	-	-
Dominance: sex control	-	-	-
Ekman 60	-	-	-
Emotion in the Eyes	-	-	-
Benton Task	-	-	-

Table 5. Summary of all findings involving a significant effect of group, lesion laterality or lesion site.

3. 11. Relationships between face processing tasks

For the two trustworthiness and dominance tasks and their two corresponding control (femininity) tasks multiple correlation coefficients were computed. These multiple correlation coefficients were calculated across the individual ratings on the task, and represent the overall performance across the 10 levels of the task. A positive coefficient (referred in the text as "overall performance coefficient") indicates that participant ratings of trustworthiness, dominance or femininity increase with the manipulated increase in trust, dominance or femininity. In other words, a positive coefficient is expected if the judgements are correct. Negative coefficients suggest impaired judgements.

These overall performance coefficients across the ten levels of each of the four tasks were compared for each of the three group comparisons described previously (see Table 6).

For both the trustworthiness and the dominance tasks the overall performance coefficients were significantly higher for controls than for patients; however these differences were not seen in the control tasks. When comparing groups according to lesion laterality the only difference found was stronger (negative) correlation values across levels for patients with right hemisphere lesions in comparison to patients with left hemisphere lesions, for the main dominance task only.

The trustworthiness and dominance overall performance coefficients were then correlated with the other face processing tasks (see Table 7) for each of the groups separately. Although some significant correlations were found for the control tasks, they are not clinically relevant.

When looking at control and patients separately, the trustworthiness and dominance overall performance coefficients were not correlated with any of the other face processing tasks.

There were no significant correlations for patients with left hemisphere lesions; however, for patients with right hemisphere lesions there was a significant positive correlation between performance on the dominance task and performance on the Mind in the Eyes task. This shows that patients who accurately recognised subtle emotional states in the Mind in the Eyes task also were more accurate at judging various degrees of dominance.

For patients with medial lesions, there were significant correlations between the trustworthiness task and accuracy for perceiving fear, and between the dominance task and accuracy for perceiving anger. This shows that patients with medial lesions who are more accurate at perceiving fear have high overall performance values for the trustworthiness task, and those who respond more accurately to angry faces tend to have high overall performance values for the trustworthiness task.

For patients with dorsolateral lesions there was one significant negative correlation; however, this should be interpreted with some caution as there were

only six patients with lesions in this area. Patients with dorsolateral lesions who are more accurate at processing sadness sow poor overall performance to the dominance task (e.g. give dominance ratings more randomly).

	Group comparison						Lesion laterality comparison						Lesion site comparison					
	Controls (N = 20)		Patients (N = 20)		Comparison (df = 38)		LH (N = 11)		RH (N = 8)		Comparison (df = 17)		Medial (N = 12)		Dorsolateral (N = 6)		Comparison (df = 16)	
	M	SD	M	SD	t	p	M	SD	M	SD	t	p	M	SD	M	SD	t	p
Trust.	***.94***	***.10***	***-.04***	***.55***	***7.8***	***< .001***	-.12	.48	.14	.63	-1.0	.339	-.01	.56	-.01	.63	0.1	.975
Dom.	***.95***	***.05***	***-.31***	***.29***	***19.1***	***< .001***	***-.18***	***.28***	***-.44***	***.24***	***2.1***	***.048***	-.36	.32	-.15	.23	-1.5	.159
Trust. Con.	.96	.04	.92	.19	0.9	.366	.97	.02	.85	.29	1.4	.170	.90	.24	.94	.06	-0.4	.679
Dom. Con.	.94	.05	.89	.21	1.0	.314	.93	.13	.81	.30	1.3	.218	.87	.25	.89	.17	-0.1	.898

Table 6. Descriptive statistics and independent t tests comparing overall performance coefficients for the trustworthiness/dominance tasks.

		Controls (N = 20)				Patients (N = 20)				LH (N = 11)				RH (N = 8)				Medial (N = 12)				Dorsolateral (N = 6)			
		Trust.	Dom.	Trust. Con.	Dom. Con.	Trust.	Dom.	Trust. Con.	Dom. Con.	Trust.	Dom.	Trust. Con.	Dom. Con.	Trust.	Dom.	Trust. Con.	Dom. Con.	Trust.	Dom.	Trust. Con.	Dom. Con.	Trust.	Dom.	Trust. Con.	Dom. Con.
Anger	r	-.030	.009	.068	.316	-.012	.230	-.315	-.364	-.385	-.090	-.158	-.481	.033	.635	-.497	-.343	.314	***.597***	-.333	-.300	-.516	-.597	-.662	-.673
	p	.901	.969	.777	.175	.959	.329	.176	.115	.242	.793	.643	.135	.938	.091	.210	.405	.319	***.041***	.291	.343	.294	.211	.152	.143
Disgust	r	-.260	.038	-.195	-.384	-.237	-.171	-.124	-.231	-.198	-.560	-.393	-.247	-.275	.336	-.154	-.271	-.157	-.011	-.156	-.289	-.214	-.742	-.703	-.426
	p	.268	.874	.409	.094	.314	.472	.604	.327	.559	.073	.231	.465	.510	.416	.716	.516	.626	.974	.628	.362	.685	.091	.120	.399
Fear	r	-.223	-.247	***-.455***	.050	.281	.165	-.137	-.154	.004	.103	-.202	-.446	.368	.098	-.164	.062	***.641***	.321	-.184	-.114	-.225	-.613	-.480	-.482
	p	.345	.293	***.044***	.835	.231	.487	.566	.518	.991	.763	.551	.169	.370	.818	.697	.884	***.025***	.310	.567	.724	.668	.196	.336	.333
Happy	r	-.103	-.075	-.200	.334	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
	p	.667	.754	.399	.151	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Sadness	r	-.110	-.172	-.124	***.484***	-.438	-.092	***.672***	***.630***	-.155	-.102	-.117	.390	-.698	-.350	***.827***	***.750***	-.480	.156	***.862***	***.748***	-.320	***-.934***	***-.888***	.144
	p	.644	.468	.604	***.031***	.053	.701	***.001***	***.003***	.650	.766	.732	.236	.054	.396	***.011***	***.032***	.114	.628	***.000***	***.005***	.537	***.006***	***.018***	.786
Surprise	r	-.149	.128	-.032	.215	.214	.059	-.127	.331	.152	-.024	.103	***.843***	.446	.067	-.300	.028	.281	.264	-.184	.096	.226	-.378	-.139	***.934***
	p	.532	.591	.894	.362	.364	.805	.594	.154	.656	.945	.763	***.001***	.269	.876	.470	.947	.376	.407	.566	.766	.667	.460	.793	***.006***
Eckman	r	-.196	-.148	-.272	.046	.057	.209	-.148	-.150	-.209	-.167	-.267	-.316	.126	.445	-.212	-.094	.382	.555	-.169	-.135	-.342	-.779	-.714	-.418
Total	p	.408	.533	.245	.849	.812	.376	.535	.527	.538	.624	.427	.343	.767	.269	.614	.825	.221	.061	.599	.677	.507	.068	.111	.409
Mind in	r	.118	.238	.000	.297	.202	.090	-.365	-.413	-.233	-.327	.237	-.136	.351	***.824***	-.524	-.538	.541	.393	-.450	-.478	-.270	-.350	-.208	-.589
the Eye	p	.619	.311	1.000	.204	.392	.707	.113	.070	.491	.326	.483	.690	.393	***.012***	.183	.169	.069	.206	.142	.116	.605	.496	.692	.218
Benton	r	-.236	.194	-.108	.119	.143	-.097	-.072	-.003	-.019	-.133	.183	.071	.484	-.315	-.264	-.130	.208	-.160	-.082	.005	.398	.554	.136	-.110
Total	p	.316	.413	.651	.616	.548	.685	.761	.989	.956	.697	.591	.837	.224	.447	.528	.759	.517	.620	.801	.989	.435	.254	.797	.835

* Where happiness accuracy reached ceiling for all participants, correlations could not be computed.

Table 7. Correlations between the trustworthiness/dominance tasks and the face processing tasks.

4. Discussion

The most important finding of this study is that patients with frontal lobe damage have significantly more difficulties than healthy controls in judging trustworthiness and dominance from facial expressions. This effect did not differ according to lesion laterality or site. Overall, this suggests that the frontal lobe has a vital role in the perception of trustworthiness and dominance from facial expressions. This finding is in line with previous reports in the literature, which suggested that patients with focal frontal lobe damage show reduced ability to infer mental states of other people from their facial expressions (e.g. Happe, Malhi and Checkley, 2001; Tranel, Bechara and Denburg, 2002; Hornak et al, 2003; McDonald et al., 2004; Kemp et al., 2013).

Importantly, difficulties in understanding others' mental states may subsequently lead to errors in predicting their actions, which may lead to behaviours that are not congruent with social expectations and norms. Indeed, several studies reported that patients with frontal damage often produce behaviours that violate social norms despite unimpaired knowledge of the social norms themselves (e.g. Beer et al, 2006). Impaired perceptions of trustworthiness and dominance may help explain this behaviour. For example, if patients with frontal damage are unable to distinguish between whether a person is trustworthy or not this may explain why they make socially inappropriate self-disclosures when talking to a stranger (Beer et al, 2006) or not having confidence in their judgement and may withdraw from social interactions (e.g. Blais and Boisvert, 2005). Similarly, misperceptions of dominance may lead to inaccurate appraisal of others' harmful intentions which could lead to aggression and antisocial behaviours (Meyer, Berman, Scheibel and Hayman, 1992; McDonald and Saunders 2005).

This study has not found significant differences between patients and controls on the other social cognition task, Mind in the Eyes Test. It is somewhat difficult to interpret this result in the context of other studies, as the literature to date presents a mixed picture. On the one hand, our results are similar to with the findings of Milders et al, (2003) who found that patients with severe TBI (with extensive bilateral damage to the frontal lobes) were able to detect subtle social emotions at levels comparable to controls. On the other hand, other studies

reported impairments on the Mind in the Eyes Test in patients with smaller lesions in the ventromedial or dorsolateral prefrontal cortex (e.g. Henry et al, 2006; Geraci et al, 2010). Since most of the patients who took part in our study had focal lesions in the medial and dorsolateral areas it was expected that they performed worse than controls on this task. There are two possible explanations for these results.

First, there seems to be sufficient evidence in the literature that the prefrontal cortex is involved in processing complex social emotion from faces. However, the opinions are divided on whether a single, highly specialised area is involved, or whether there are several interconnected areas spread over ventromedial and dorsolateral regions (for a review see Radice-Neumann et al, 2007). There are also mixed results in the literature with regard to the involvement of the left, right or bilateral areas (e.g. McDonald 2013). Since most of the patients who took part in this study had focal unilateral lesions, it is possible that most of them were able to rely on unaffected areas and perform at levels comparable to controls.

Second, most studies that used the Mind in the Eyes Test to assess social cognition on patients with frontal lobe damage, were conducted with TBI patients. Very frequently diffuse axonal injury often occurs in TBI as a result of asymmetrical mechanical loading at cellular level (e.g., Smith, Meaney and Shull, 2003; Cloots, van Dommelen, Kleiven and Geers, 2013). Since frontal areas exhibit a high degree of interconnectivity, it is possible that the impairment in complex social emotion recognition reported in some of the previous research may be due to connectivity problems in addition to focal damage to specific areas. This idea is further supported by the findings of Henry et al, (2009) who found that MS patients performed significantly worse than healthy controls at the Mind in the Eyes Test. Since the patient sample presented in this study had focal surgical lesions, it is possible that the interconnectivity with other areas remained largely unaffected. This may explain why the patients' complex social emotion recognition appears relatively intact.

Additionally, it is important to mention that there was a trend in the data, with patients performing slightly worse than controls on the Eyes in the Mind test. In a larger sample size this could achieve statistical significance. It is also possible

that not all complex social emotions are equally well recognised in patients with frontal damage. For example, Martins, Faisca, Esteves, Simao, et al. (2012) found that patients with lesions in the medial areas of prefrontal cortex showed significant impairments in recognising two social emotions: arrogance and jealousy, but relatively intact recognition of guilt. Unfortunately, it is not possible to analyse individual complex social emotions in the Mind in the Eyes Test. However, future research should investigate this possibility by using different instruments to assess the recognition of complex social emotions from faces.

This study has also not found any significant differences in basic emotion recognition abilities between patients and healthy controls. Similarly, Shamay-Tsoory, Tomer, Goldsher, Berger et al, (2004) did not find impairments in basic facial emotion recognition (Ekman 60 task) in patients with lesions in the prefrontal cortex. McDonald and Saunders (2005) found that only a few participants with TBI (eight out of 34) showed impaired facial emotion recognition from still photographs. Other studies suggested that only the recognition of negative facial emotions is impaired in patients with frontal TBI whilst positive emotions are recognised at the same level as controls (Jackson & Moffat, 1997, Blair & Cipolotti, 2000; Hopkins, Dywan & Segalowitz, 2002, Kemp, Berthel, Dufour, Despres, et al., 2013). In contrast, there are several studies that reported impaired facial emotion recognition across all emotions in patients with frontal lobe damage (Mitchell, Avny & Blair, 2006; Henry, Phillips, Beatty, McDonald et al., 2009; Williams and Wood, 2010; Callahan, Ueda, Sakata, Plamondon and Murai, 2011; Spikman, et al., 2012; Dal Monte, Krueger, Solomon, Schintu, et al., 2013; Spikman, Milders, Visser-Keizer, Westerhof-Evers, et al., 2013; Njomboro, et al., 2014). It has been proposed that the orbitofrontal cortex (OFC) and amygdala play a crucial role in basic facial emotion recognition (e.g. see Radice-Neumann et al, 2007; McDonald, 2013). Since only three patients had OFC damage, and no patients had amygdala damage, it is perhaps not surprising that no significant impairments in basic facial emotion recognition were found.

This study generally found that found that anger and fear and disgust were recognised with significant less accuracy than happiness, sadness and surprise. This effect was observed in both patients and controls. Previous studies conducted on non-clinical populations (presenting with no neurological or

psychiatric conditions) have shown that happiness is recognised with far greater accuracy (87-97%) than negative emotions, particularly fear (68-88%; Ekman, Sorenson and Friesen, 1969). Malatesta, Izard, Culver and Nicolich (1987) found that the accuracy of recognition of anger, fear and sadness decreases with age whereas Moreno, Borod, Welkowitz and Alpert, (1993) found improved recognition of some positive emotions such as happiness, and a slight decline in the recognition of sadness. Calder, Keane, Manly et al., (2003) reported a progressive reduction in the recognition of fear and anger with increasing age. Thus, the findings regarding basic emotion recognition presented in this study are broadly in line with previous research. The fact that patients showed the same pattern of basic emotion recognition as controls adds further support to the idea the their basic emotion recognition is unimpaired. However, Oosterhof & Todorov (2009) interpersonal contact model, proposes that trustworthy and dominance judgements are highly correlated with basic facial emotions. Nevertheless, our findings suggest that despite unimpaired basic emotion recognition, patients with frontal lobe damage struggled with trustworthiness and dominance judgements relative to healthy controls. Interestingly, correlational analysis suggests that patients with medial lesions who are more accurate at perceiving fear also show very accurate ratings for the trustworthiness task. Similarly, those who recognise more accurately angry faces tend to show accurate ratings for the trustworthiness task.

Taken together these findings seem to suggest that basic emotion information extracted from facial expressions may be a prerequisite for trustworthiness and dominance judgements. However, further processing must occur in areas which are not involved with basic emotion processing. If those areas are affected, trustworthiness and dominance can be impaired whereas basic emotion recognition remains relatively unaffected. Correlational analysis also showed that patients with right hemisphere lesions who accurately recognised subtle emotional states (Mind in the Eyes Test) were also more accurate at judging various degrees of dominance. This may suggest cascade-type processing in the right medial frontal cortex whereby basic facial emotion information may be utilised for higher order emotional processing (e.g. interpreting complex social emotions), which in turn may be used to facilitate interpersonal contact. Future research should further investigate the possibility that complex emotion may

also be driving interpersonal contact in addition to basic emotion as originally proposed by Todorov et al.'s (2008) model.

This study found that participants with frontal lesions performed more poorly than controls on executive function tasks, but there was no significant correlation between their performance on those tasks and social cognition or emotion recognition tasks. This seems to suggest that executive function difficulties have no clear relationship with trustworthiness and dominance judgements. However, individual differences may account for this lack of relationship. There were no differences between the two groups on basic facial processing tasks (e.g. BFRT) suggesting the effects reported here are not due to overall difficulties in face processing.

This study has several limitations. First, due to unavailability of scans for several patients, the exact lesion size could not be ascertained. Therefore we are unable to accurately determine how extensive the lesions were that created the patterns of impairment reported in this study. Second, due to time limitations, the number of participants with OFC damage was relatively low. Thus, we cannot directly compare our results with other studies that reported various degrees of impairment in basic facial emotion recognition in patients with focal OFC damage. Future research should address this limitation for two reasons. A plethora of studies mentioned in this paper suggested that OFC lesions are likely to produce impairments in basic facial emotion recognition (e.g. McDonald, 2013). If lesions in the OFC do result in impairments in basic facial emotion recognition and also in trustworthiness/dominance judgements, this would provide strong support for Todorov et al.'s (2008) model. However, if impaired basic emotion recognition is observed but trustworthiness/dominance judgements are intact, this would suggest Todorov et al.'s model needs to take into account other factors, such as the ability to interpret complex social emotions as suggested by the results of the current study. It is unclear how these impairments in trustworthiness/dominance judgements relate to other social cognition skills (e.g. ToM, empathy, socio-moral judgements) and impairments in executive functioning.

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6. Appendices

Appendix 1: Descriptive statistics for the trustworthiness task for controls and patients, and a comparison using simple planned comparisons.

	Controls		Patients		p	Dir.
	M	SE	M	SE		
Trustworthiness: Level 1	1.7	.4	4.1	.4	.001	C < P
Trustworthiness: Level 2	2.5	.4	3.4	.4	.138	-
Trustworthiness: Level 3	2.6	.4	4.2	.4	.010	C < P
Trustworthiness: Level 4	3.4	.3	4.3	.3	.123	-
Trustworthiness: Level 5	4.1	.3	3.9	.3	.707	-
Trustworthiness: Level 6	3.8	.4	4.5	.4	.345	-
Trustworthiness: Level 7	4.5	.4	4.4	.4	.949	-
Trustworthiness: Level 8	5.0	.5	4.3	.5	.377	-
Trustworthiness: Level 9	5.2	.4	5.1	.4	.921	-
Trustworthiness: Level 10	6.1	.4	4.5	.4	.024	C >P

Note: Means are Estimated Marginal Means, corrected for the three HADS-SIS confound variables. The p value is for the simple planned comparison between controls and patients. The direction is given for any significant differences.

Appendix 2: Descriptive statistics for the trustworthiness task for patients with left and right hemisphere lesions, and a comparison using simple planned comparisons.

	Left hemisphere		Right hemisphere		p	Dir.
	M	SE	M	SE		
Trustworthiness: Level 1	4.2	.56	3.9	.67	.747	-
Trustworthiness: Level 2	3.7	.46	4.3	.55	.397	-
Trustworthiness: Level 3	4.6	.47	4.2	.56	.549	-
Trustworthiness: Level 4	3.9	.39	4.8	.47	.178	-
Trustworthiness: Level 5	3.8	.34	4.4	.40	.346	-
Trustworthiness: Level 6	3.8	.55	4.7	.66	.347	-
Trustworthiness: Level 7	3.8	.50	4.5	.59	.378	-
Trustworthiness: Level 8	3.7	.62	4.5	.74	.430	-
Trustworthiness: Level 9	4.7	.55	4.4	.65	.706	-
Trustworthiness: Level 10	4.1	.59	4.4	.70	.830	-

Note: Means are Estimated Marginal Means, corrected for the three HADS-SIS confound variables. The p value is for the simple planned comparison between left and right hemisphere lesions. The direction is given for any significant differences.

Appendix 3: Descriptive statistics for the trustworthiness task for patients with medial and dorsolateral lesions, and a comparison using simple planned comparisons.

	Medial		Dorsolateral		p	Dir.
	M	SE	M	SE		
Trustworthiness: Level 1	4.1	0.6	4.3	0.8	.848	-
Trustworthiness: Level 2	3.9	0.5	4.3	0.7	.658	-
Trustworthiness: Level 3	4.2	0.4	5.2	0.5	.185	-
Trustworthiness: Level 4	4.7	0.4	4.3	0.6	.611	-
Trustworthiness: Level 5	3.9	0.3	4.2	0.5	.605	-
Trustworthiness: Level 6	4.2	0.5	4.2	0.8	.993	-
Trustworthiness: Level 7	4.7	0.4	3.1	0.6	.051	-
Trustworthiness: Level 8	4.1	0.7	3.6	1.0	.650	-
Trustworthiness: Level 9	4.6	0.5	4.7	0.7	.894	-
Trustworthiness: Level 10	4.1	0.6	4.8	0.8	.484	-

Note: Means are Estimated Marginal Means, corrected for the three HADS-SIS confound variables. The p value is for the simple planned comparison between medial and dorsolateral lesions. The direction is given for any significant differences.

Appendix 4: Descriptive statistics for the trustworthiness sex control task for controls and patients, and a comparison using simple planned comparisons.

	Controls		Patients		p	Dir.
	M	SE	M	SE		
Trustworthiness/sex: Level 1	1.8	.3	1.9	.3	.850	-
Trustworthiness/sex: Level 2	1.8	.3	2.8	.3	.041	C < P
Trustworthiness/sex: Level 3	2.2	.3	3.3	.3	.032	C < P
Trustworthiness/sex: Level 4	2.9	.3	4.0	.3	.021	C < P
Trustworthiness/sex: Level 5	3.6	.2	4.4	.2	.016	C < P
Trustworthiness/sex: Level 6	3.8	.2	5.0	.2	.002	C < P
Trustworthiness/sex: Level 7	4.7	.2	5.4	.2	.032	C < P
Trustworthiness/sex: Level 8	5.5	.2	5.8	.2	.269	-
Trustworthiness/sex: Level 9	6.0	.2	6.2	.2	.346	-
Trustworthiness/sex: Level 10	6.2	.2	6.7	.2	.081	-

Note: Means are Estimated Marginal Means, corrected for the three HADS-SIS confound variables. The p value is for the simple planned comparison between controls and patients. The direction is given for any significant differences.

Appendix 5: Descriptive statistics for the trustworthiness sex control task for patients with left and right hemisphere lesions, and a comparison using simple planned comparisons.

	Left hemisphere		Right hemisphere		p	Dir.
	M	SE	M	SE		
Trustworthiness/sex: Level 1	1.6	0.4	2.6	0.5	.173	-
Trustworthiness/sex: Level 2	2.3	0.3	3.3	0.4	.090	-
Trustworthiness/sex: Level 3	2.7	0.3	3.9	0.4	.045	L<R
Trustworthiness/sex: Level 4	3.4	0.3	4.5	0.4	.046	L<R
Trustworthiness/sex: Level 5	4.0	0.3	4.7	0.3	.094	-
Trustworthiness/sex: Level 6	4.6	0.2	5.1	0.2	.155	-
Trustworthiness/sex: Level 7	5.2	0.2	5.5	0.2	.382	-
Trustworthiness/sex: Level 8	5.9	0.2	5.7	0.2	.590	-
Trustworthiness/sex: Level 9	6.3	0.1	6.1	0.2	.369	-
Trustworthiness/sex: Level 10	6.7	0.1	6.4	0.2	.191	-

Note: Means are Estimated Marginal Means, corrected for the three HADS-SIS confound variables. The p value is for the simple planned comparison between left and right hemisphere lesions. The direction is given for any significant differences.

Appendix 6: Descriptive statistics for the trustworthiness sex control task for patients with medial and dorsolateral lesions, and a comparison using simple planned comparisons.

	Medial		Dorsolateral		p	Dir.
	M	SE	M	SE		
Trustworthiness/sex: Level 1	2.4	0.4	1.6	0.6	.341	-
Trustworthiness/sex: Level 2	2.9	0.3	2.5	0.5	.486	-
Trustworthiness/sex: Level 3	3.4	0.4	2.8	0.5	.460	-
Trustworthiness/sex: Level 4	4.1	0.3	3.3	0.5	.169	-
Trustworthiness/sex: Level 5	4.5	0.2	4.0	0.3	.239	-
Trustworthiness/sex: Level 6	5.0	0.1	4.6	0.2	.222	-
Trustworthiness/sex: Level 7	5.5	0.2	5.3	0.2	.603	-
Trustworthiness/sex: Level 8	5.8	0.2	6.0	0.3	.705	-
Trustworthiness/sex: Level 9	6.2	0.1	6.3	0.2	.955	-
Trustworthiness/sex: Level 10	6.6	0.1	6.5	0.2	.565	-

Note: Means are Estimated Marginal Means, corrected for the three HADS-SIS confound variables. The p value is for the simple planned comparison between medial and dorsolateral lesions. The direction is given for any significant differences.

Appendix 7: Descriptive statistics for the dominance task for controls and patients, and a comparison using simple planned comparisons.

	Controls		Patients		p	Dir.
	M	SE	M	SE		
Dominance: Level 1	1.8	.3	4.8	.3	< .001	C < P
Dominance: Level 2	2.3	.4	3.9	.4	.014	C < P
Dominance: Level 3	2.3	.5	4.6	.5	.009	C < P
Dominance: Level 4	3.6	.5	4.1	.5	.483	-
Dominance: Level 5	4.1	.5	4.3	.5	.772	-
Dominance: Level 6	4.6	.4	3.6	.4	.137	-
Dominance: Level 7	5.6	.4	3.3	.4	.002	C >P
Dominance: Level 8	6.0	.3	3.3	.3	< .001	C >P
Dominance: Level 9	6.3	.4	3.2	.4	< .001	C >P
Dominance: Level 10	6.5	.4	3.0	.4	< .001	C >P

Note: Means are Estimated Marginal Means, corrected for the three HADS-SIS confound variables. The p value is for the simple planned comparison between controls and patients. The direction is given for any significant differences.

Appendix 8: Descriptive statistics for the dominance task for patients with left and right hemisphere lesions, and a comparison using simple planned comparisons.

	Left hemisphere		Right hemisphere		p	Dir.
	M	SE	M	SE		
Dominance: Level 1	4.7	0.4	4.5	0.5	.827	-
Dominance: Level 2	4.1	0.5	4.2	0.6	.911	-
Dominance: Level 3	3.8	0.7	4.7	0.8	.395	-
Dominance: Level 4	3.9	0.6	4.5	0.7	.552	-
Dominance: Level 5	4.5	0.6	4.0	0.8	.644	-
Dominance: Level 6	4.1	0.5	4.1	0.6	.987	-
Dominance: Level 7	3.9	0.5	3.9	0.6	.953	-
Dominance: Level 8	3.9	0.5	3.2	0.6	.381	-
Dominance: Level 9	3.6	0.6	3.5	0.7	.920	-
Dominance: Level 10	3.5	0.6	3.0	0.7	.617	-

Note: Means are Estimated Marginal Means, corrected for the three HADS-SIS confound variables. The p value is for the simple planned comparison between patients with left and right hemisphere lesions. The direction is given for any significant differences.

Appendix 9: Descriptive statistics for the dominance task for patients with medial and dorsolateral lesions, and a comparison using simple planned comparisons.

	Medial		Dorsolateral		p	Dir.
	M	SE	M	SE		
Dominance: Level 1	5.1	0.4	3.8	0.6	.091	-
Dominance: Level 2	4.3	0.4	4.0	0.6	.675	-
Dominance: Level 3	4.5	0.6	3.2	0.9	.240	-
Dominance: Level 4	4.4	0.6	4.0	0.8	.709	-
Dominance: Level 5	4.0	0.6	4.8	0.9	.476	-
Dominance: Level 6	3.7	0.5	4.4	0.8	.469	-
Dominance: Level 7	3.8	0.5	3.6	0.7	.811	-
Dominance: Level 8	3.4	0.4	3.7	0.6	.650	-
Dominance: Level 9	3.5	0.5	3.2	0.7	.698	-
Dominance: Level 10	2.8	0.6	3.9	0.8	.308	-

Note: Means are Estimated Marginal Means, corrected for the three HADS-SIS confound variables. The p value is for the simple planned comparison between patients with medial and dorsolateral lesions. The direction is given for any significant differences.

Appendix 10: Descriptive statistics for the dominance sex control task for controls and patients, and a comparison using simple planned comparisons.

	Controls		Patients		p	Dir.
	M	SE	M	SE		
Dominance/sex: Level 1	1.7	.3	2.1	.3	.483	-
Dominance /sex: Level 2	2.4	.3	2.5	.3	.735	-
Dominance /sex: Level 3	3.0	.2	2.8	.2	.679	-
Dominance /sex: Level 4	3.6	.2	3.6	.2	.916	-
Dominance /sex: Level 5	3.8	.2	4.2	.2	.262	-
Dominance /sex: Level 6	4.2	.2	4.6	.2	.328	-
Dominance /sex: Level 7	4.6	.2	5.2	.2	.135	-
Dominance /sex: Level 8	5.5	.2	5.4	.2	.880	-
Dominance /sex: Level 9	6.0	.2	6.0	.2	.997	-
Dominance /sex: Level 10	6.4	.2	6.3	.2	.842	-

Note: Means are Estimated Marginal Means, corrected for the three HADS-SIS confound variables. The p value is for the simple planned comparison between controls and patients. The direction is given for any significant differences.

Appendix 11: Descriptive statistics for the dominance sex control task for patients with left and right hemisphere lesions, and a comparison using simple planned comparisons.

	Left hemisphere		Right hemisphere		p	Dir.
	M	SE	M	SE		
Dominance/sex: Level 1	1.7	0.4	2.7	0.5	.198	-
Dominance /sex: Level 2	2.5	0.3	3.0	0.4	.407	-
Dominance /sex: Level 3	2.9	0.3	3.3	0.3	.291	-
Dominance /sex: Level 4	3.6	0.3	3.8	0.3	.639	-
Dominance /sex: Level 5	4.4	0.3	4.2	0.4	.628	-
Dominance /sex: Level 6	4.5	0.2	4.8	0.3	.475	-
Dominance /sex: Level 7	5.3	0.3	4.9	0.3	.354	-
Dominance /sex: Level 8	5.7	0.2	5.7	0.2	.955	-
Dominance /sex: Level 9	6.2	0.1	6.1	0.2	.540	-
Dominance /sex: Level 10	6.5	0.2	6.2	0.2	.315	-

Note: Means are Estimated Marginal Means, corrected for the three HADS-SIS confound variables. The p value is for the simple planned comparison between patients with left and right hemisphere lesions. The direction is given for any significant differences.

Appendix 12: Descriptive statistics for the dominance sex control task for patients with medial and dorsolateral lesions, and a comparison using simple planned comparisons.

	Medial		Dorsolateral		p	Dir.
	M	SE	M	SE		
Dominance/sex: Level 1	2.5	0.4	1.8	0.6	.388	-
Dominance /sex: Level 2	2.6	0.3	3.0	0.5	.568	-
Dominance /sex: Level 3	3.1	0.3	3.3	0.4	.687	-
Dominance /sex: Level 4	3.8	0.2	3.7	0.3	.861	-
Dominance /sex: Level 5	4.2	0.3	4.7	0.4	.320	-
Dominance /sex: Level 6	4.8	0.2	4.5	0.3	.358	-
Dominance /sex: Level 7	5.3	0.2	4.8	0.3	.300	-
Dominance /sex: Level 8	5.8	0.2	5.2	0.2	.060	-
Dominance /sex: Level 9	6.3	0.1	6.0	0.2	.171	-
Dominance /sex: Level 10	6.5	0.2	6.1	0.2	.236	-

Note: Means are Estimated Marginal Means, corrected for the three HADS-SIS confound variables. The p value is for the simple planned comparison between patients with medial and dorsolateral lesions. The direction is given for any significant differences.

Appendix 13: Descriptive statistics for the Ekman 60 task for controls and patients, and a comparison using simple planned comparisons.

	Controls		Patients		p	Dir.
	M	SE	M	SE		
Anger	7.7	.5	7.1	.5	.557	-
Disgust	8.6	.5	7.8	.5	.382	-
Fear	7.4	.5	7.4	.5	.948	-
Happiness	9.9	.0	10.0	.0	.192	-
Sadness	8.8	.4	8.7	.4	.939	-
Surprise	9.0	.3	9.8	.3	.070	-

Note: Means are Estimated Marginal Means, corrected for the three HADS-SIS confound variables. The p value is for the simple planned comparison between controls and patients. The direction is given for any significant differences.

Appendix 14: Descriptive statistics for the Ekman 60 task for patients with left and right hemisphere lesions, and a comparison using simple planned comparisons.

	Left hemisphere		Right hemisphere		p	Dir.
	M	SE	M	SE		
Anger	6.2	0.6	7.1	0.7	.409	-
Disgust	7.7	0.5	7.6	0.6	.894	-
Fear	6.2	0.6	6.2	0.8	1.000	-
Happiness	10.0	0.0	10.0	0.0	-	-
Sadness	8.8	0.3	8.7	0.3	.898	-
Surprise	9.8	0.2	9.4	0.2	.352	-

Note: Means are Estimated Marginal Means, corrected for the three HADS-SIS confound variables. The p value is for the simple planned comparison between patients with left and right hemisphere lesions. The direction is given for any significant differences.

Appendix 15: Descriptive statistics for the Ekman 60 task for patients with medial and dorsolateral lesions, and a comparison using simple planned comparisons.

	Medial		Dorsolateral		p	Dir.
	M	SE	M	SE		
Anger	6.3	0.6	6.1	0.8	.839	-
Disgust	7.4	0.5	7.8	0.7	.641	-
Fear	5.5	0.6	6.5	0.8	.371	-
Happiness	10.0	0.0	10.0	0.0	-	-
Sadness	8.6	0.3	8.7	0.4	.861	-
Surprise	9.6	0.2	9.6	0.3	.989	-

Note: Means are Estimated Marginal Means, corrected for the three HADS-SIS confound variables. The p value is for the simple planned comparison between patients with medial and dorsolateral lesions. The direction is given for any significant differences.

Appendix 16: Descriptive statistics for the Emotion in the Eyes and Benton face recognition tasks for and comparisons.

	M	SE	M	SE	p	Dir.
	Controls		Patients			
Emotion in the eyes	26.2	1.5	21.3	1.5	.063	-
Benton face recognition	50.4	.8	50.1	.8	.849	-
	Left hemisphere		Right hemisphere			
Emotion in the eyes	18.9	2.0	23.1	2.3	.212	-
Benton face recognition	50.2	1.0	49.6	1.2	.731	-
	Medial		Dorsolateral			
Emotion in the eyes	20.6	1.9	17.2	2.8	.356	-
Benton face recognition	50.1	0.9	49.7	1.3	.834	-

Note: Means are Estimated Marginal Means, corrected for the three HADS-SIS confound variables. The p value is for the univariate ANCOVA comparing the two groups. The direction is given for any significant differences.

Health Research Authority
NRES Committee London - Surrey Borders
Research Ethics Committee (REC) London Centre
Ground Floor
Skipton House
80 London Road
London
SE1 6LH

Telephone: 020 797 22561
Fax:020 797 22592

19 June 2014

Dr Matei Vladeanu
32 Larksfield
Englefield Green
Egham
TW20 0RD

Dear Dr Vladeanu

Study title:	**Social cognition and emotional processing in patients with focal frontal lobe damage**
REC reference:	**14/LO/0559**
Protocol number:	**001**
IRAS project ID:	**141727**

Thank you for your letter of 04 June 2014, responding to the Committee's request for further information on the above research and submitting revised documentation.

The further information was considered in correspondence by a Sub-Committee of the REC. A list of the Sub-Committee members is attached.

We plan to publish your research summary wording for the above study on the HRA website, together with your contact details. Publication will be no earlier than three months from the date of this opinion letter. Should you wish to provide a substitute contact point, require further information, or wish to make a request to postpone publication, please contact the REC Manager, Mr Atul Patel, nrescommittee.london-surreyborders@nhs.net.

Confirmation of ethical opinion

On behalf of the Committee, I am pleased to confirm a favourable ethical opinion for the above research on the basis described in the application form, protocol and supporting documentation as revised, subject to the conditions specified below.

Conditions of the favourable opinion

The favourable opinion is subject to the following conditions being met prior to the start of the study.

You should notify the REC in writing once all conditions have been met (except for site approvals from host organisations) and provide copies of any revised documentation with updated version numbers. The REC will acknowledge receipt and provide a final list of the approved documentation for the study, which can be made available to host organisations to facilitate their permission for the study. Failure to provide the final versions to the REC may cause delay in obtaining permissions.

Management permission or approval must be obtained from each host organisation prior to the start of the study at the site concerned.

Management permission ("R&D approval") should be sought from all NHS organisations involved in the study in accordance with NHS research governance arrangements.

Guidance on applying for NHS permission for research is available in the Integrated Research Application System or at http://www.rdforum.nhs.uk.

Where a NHS organisation's role in the study is limited to identifying and referring potential participants to research sites ("participant identification centre"), guidance should be sought from the R&D office on the information it requires to give permission for this activity.

For non-NHS sites, site management permission should be obtained in accordance with the procedures of the relevant host organisation.

Sponsors are not required to notify the Committee of approvals from host organisations

Registration of Clinical Trials

All clinical trials (defined as the first four categories on the IRAS filter page) must be registered on a publically accessible database within 6 weeks of recruitment of the first participant (for medical device studies, within the timeline determined by the current registration and publication trees).

There is no requirement to separately notify the REC but you should do so at the earliest opportunity e.g when submitting an amendment. We will audit the registration details as part of the annual progress reporting process.

To ensure transparency in research, we strongly recommend that all research is registered but for non clinical trials this is not currently mandatory.

If a sponsor wishes to contest the need for registration they should contact Catherine Blewett (catherineblewett@nhs.net), the HRA does not, however, expect exceptions to be made. Guidance on where to register is provided within IRAS.

It is the responsibility of the sponsor to ensure that all the conditions are complied with before the start of the study or its initiation at a particular site (as applicable).

Ethical review of research sites

NHS sites

The favourable opinion applies to all NHS sites taking part in the study, subject to management permission being obtained from the NHS/HSC R&D office prior to the start of the study (see "Conditions of the favourable opinion" below).

Non-NHS sites

Approved documents

The final list of documents reviewed and approved by the Committee is as follows:

Document	*Version*	*Date*
Covering letter on headed paper		28 April 2014
Letters of invitation to participant	1	24 April 2014
Other [CV Lidia Hervas]		
Other [CV Reniner Spregelmayer]		
Other [Template Letter Confirming Assessment]	001	19 November 2013
Participant consent form [Healthy Volunteer]	2	24 April 2014
Participant consent form [Patient]	2	24 April 2014
Participant information sheet (PIS) [Patient]	3	02 June 2014
Participant information sheet (PIS) [Healthy Volunteer]	3	02 June 2014
REC Application Form		
Research protocol or project proposal	001	16 December 2013
Response to Request for Further Information		
Response to Request for Further Information		03 June 2014
Summary CV for Chief Investigator (CI)	Matel Vladeanu	
Validated questionnaire [HADS SIS]		
Validated questionnaire [DEX]		

Statement of compliance

The Committee is constituted in accordance with the Governance Arrangements for Research Ethics Committees and complies fully with the Standard Operating Procedures for Research Ethics Committees in the UK.

After ethical review

Reporting requirements

The attached document *"After ethical review – guidance for researchers"* gives detailed guidance on reporting requirements for studies with a favourable opinion, including:

- Notifying substantial amendments
- Adding new sites and investigators

- Notification of serious breaches of the protocol
- Progress and safety reports
- Notifying the end of the study

The HRA website also provides guidance on these topics, which is updated in the light of changes in reporting requirements or procedures.

Feedback

You are invited to give your view of the service that you have received from the National Research Ethics Service and the application procedure. If you wish to make your views known please use the feedback form available on the HRA website:
http://www.hra.nhs.uk/about-the-hra/governance/quality-assurance/

We are pleased to welcome researchers and R & D staff at our NRES committee members' training days – see details at http://www.hra.nhs.uk/hra-training/

14/LO/0559	**Please quote this number on all correspondence**

With the Committee's best wishes for the success of this project.

Yours sincerely

pp

Sir Adrian Baillie
Chair

Email:nrescommittee.london-surreyborders@nhs.net

Enclosures: *List of names and professions of members who were present at the meeting and those who submitted written comments*

"After ethical review – guidance for researchers"

Copy to: *Dr. Zoe Harris, Research Office,*

NRES Committee London - Surrey Borders

Attendance at Sub-Committee of the REC meeting on 11 June 2014

Committee Members:

Name	*Profession*	*Present*	*Notes*
Sir Adrian Baillie	Financial Investment Advisor	Yes	
Mr Dominic Fairclough	Solicitor	Yes	

Also in attendance:

Name	*Position (or reason for attending)*
Mr Atul Patel	REC Manager

King's College Hospital NHS Foundation Trust
Joint Neuro-Oncology Clinic
Suite 5, Golden Jubilee Wing,
Denmark Hill, London, SE5 9RS

[Address]

[Date]

Dear [Name],

We are writing to inform you of a research study you could potentially be involved in, if you wish to do so. We are contacting you because you had surgery done at the Joint Neuro-Oncology Clinic at King's College Hospital. Everyone who has received treatment from this service within the last six months and consented to be on the research register, is being asked if they would like to take part.

What is this research about?

We are interested in finding out whether people experience any difficulties after brain surgery, particularly with the way they form impressions of other people. In our day-to-day life, when we meet new people we form impressions of them very quickly, usually based on their appearance and the emotion they show on their faces. We may approach someone and start to chat if they appear relaxed and smiling, or we leave them alone if they appear tense or angry. Psychological studies suggested that the frontal part of the brain (also known as the Frontal Lobes) play a major role in making these social judgments. After having surgery on this part of the brain, some people may find it more difficult to form accurate impressions of people they come in contact with. Consequently, they may find meeting new people or taking part in social situations (such as a party) more stressful.

We would like to develop new ways of helping people who experience these difficulties. Therefore, we would like to ask for your help. We would like to understand:

- How well you can interpret simple facial expressions by looking at pictures of faces
- Whether you consider some people more approachable or trustworthy than others (by just looking at their face).

Even if you do not think your abilities are different in any way, we would still like to invite you to take part in this research. The answers are provided for you, you only have to chose the one that seems the most accurate. It is important to note that there are **no right or wrong answers**!

We would also ask you to complete a series of short tasks that measure thinking processes such as concentration, memory, planning and problem solving. This research will take part at King's College London (address and map will be provided to you in future correspondence if you're interested in taking part). We will be able to contribute £10 to your travel expenses (payable in cash when you attend).

Who is organizing this research?

The research is led by Dr. Matei Vladeanu. He is a Clinical Psychologist in Training at the Institute of Psychiatry, King's College London. Dr. Vladeanu is supervised by:

- Dr Lidia Yágüez (Lecturer in Clinical Psychology; Academic Director of the D.Clin.Psy Training Programme at the Institute of Psychiatry, King's College London; and Honorary Clinical Psychologist/Neuropsychologist at King's College Hospital NHS Foundation Trust).
- Dr Keyoumars Ashkan, Consultant Neurosurgeon and Reader in Neurosurgery, King's College Hospital NHS Foundation Trust.

Where can I find more information about this study?

We have enclosed a detailed information sheet. You can also contact directly Dr. Matei Vladeanu who is leading this research:
Telephone: 07872 160 262

Email: matei.vladeanu@kcl.ac.uk
Address: 3rd Floor, 4 Winsor Walk, Denmark Hill, SE5 8AF

Do I have to take part?

No. Taking part in this research is your choice. You do not need to take part if you do not want to.

If you **are interested** in participating, please let us know by contacting a member of the clinical care team by phone **020 3299 4151** or email: **kch-tr.neuro-oncology@nhs.net.** You can also contact Dr. Vladeanu (lead researcher) directly at telephone: 07872 160 262, or email: matei.vladeanu@kcl.ac.uk or by letter (postal address: 3rd Floor, 4 Winsor Walk, Denmark Hill, London SE5 8AF)

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Yours sincerely,

PP

Dr Keyoumars Ashkan,
Consultant Neurosurgeon and Reader in Neurosurgery

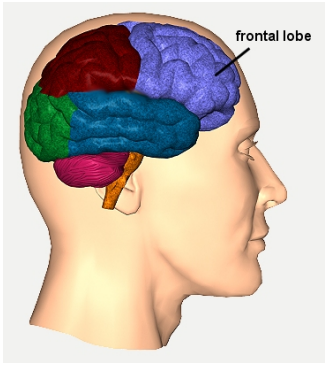
King's College Hospital NHS Foundation Trust | Institute of Psychiatry at The Maudsley | King's College London

Social Cognition and Facial Emotions:

Information Sheet

1. What is the purpose of this research?

People can form impressions of other people very quickly, usually based on their appearance and the emotion they show on their faces. For example if someone appears relaxed and is smiling, it is probably okay to approach and start a conversation. On the other hand, if someone is frowning and appears tense or angry, it may not be the best time to approach him/her and try to make conversation. Psychological studies suggested that the frontal part of the brain (also known as the Frontal Lobes) plays a major role in making these social judgments. The Frontal Lobes (shown in purple in the picture on the right) are one of the four main lobes or regions of the brain. They are positioned at the front region of the brain and are involved in lots of essential functions such as: movement, decision-making, problem solving, and planning. Very importantly for this study, the Frontal Lobes are involved in the ability to recognize future consequences resulting from current actions, to choose between good and bad actions (or better and best), interpret subtle emotions (such as guilt or admiration) and suppress socially



Frontal Lobe of the brain

unacceptable responses (such as laughing at someone who is showing saddnes and is tearful).

After having surgery on this part of the brain (the Frontal Lobe), some people may find it more difficult to form accurate impressions of people they come in contact with. Consequently, they may find meeting new people or taking part in social situations (such as a party) more stressful. We would like to develop new ways of helping people through this stressful time. To begin with, we need to find out what might have changed when you are trying to form an impression of someone else. For example, we are interested to find out how accurately you can interpret simple facial expressions (such as happiness, anger, sadness) or more complex ones (such as guilt, admiration or thoughtfulness). Also, we are interested to see whether you consider some people more approachable or trustworthy than others.

2. Why have you asked me to take part?

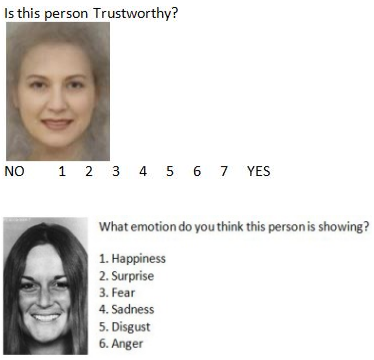
We have asked you to take part because you had surgery done at the Joint Neuro-Oncology Clinic at King's College Hospital. Everyone who has received treatment from this service within the last six months and consented to be on the research register, is being asked if they would like to take part.

3. What will I be asked to do?

We will ask you to complete a series of short tasks that measure thinking processes such as concentration, memory, planning and problem solving.

We will also ask you to look at some pictures of people you have never met before and make some judgements such as:

- How approachable do they seem to you?
- How trustworthy do they seem to you?
- What emotion do you think they are expressing?



Possible answers are provided for you, you only have to choose the one that seems the most accurate. It is important to note that there are **no right or wrong answers**! The pictures will be presented on a computer screen, so it is important to have your glasses with you (if you normally wear glasses).

Before we ask you to complete the tasks and answer these questions, you will need to sign a consent form to say that you would like to take part.

4. How long will this research take?

It will take maximum 2 hours to complete all the tasks and answer all the questionnaires. You do not have to answer them all at one time. You can take as many breaks as you need.

5. Do I have to take part?

No. Taking part in this research is your choice. You do not need to take part if you do not want to.

6. Where do I need to go?

We would like to invite you to attend an appointment at King's College London. If you are unable to attend this appointment we can make alternative arrangements to visit you at home. We will be able pay you £10 for taking part in this research.

If you're unable to travel to King's College, the lead researcher (Dr. Matei Vladeanu) can visit you at home. He will bring with him all materials necessary for the study - you do not have to provide anything. This visit will be arranged with you in advance, at a date and time that is convenient for you. Dr Vladeanu will be conducting this visit in accordance to the Trust's Lone Working and Research Policies.

7. What will you do with my answers?

You will be given a code, so that your answers to questions are anonymous. They will be kept in a locked filing cabinet in a secure office at King's College, London. Only the researchers involved in this study will know your name and be able to identify you.

If you are interested, we can send you a summary of what we find. The findings will also be written up as part of a doctoral thesis and described in a scientific paper. Your name or any personal information will not be shown in any reports.

We will keep all questionnaires for 10 years. Then they will be destroyed securely by shredding any paper records and permanently deleting information held on computer.

8. Are there any benefits for me?

This research may not help you directly. The aim of our research is to understand how well people form impressions of others and how accurately they can interpret emotions shown on people's faces after they have had surgery on the front part of the brain. By taking part in this research you will be helping us to achieve this.

9. Will there be any risks involved?

We do not think that you will be exposed to any risks if you take part in this study. You do not have to answer questions that you feel uncomfortable answering. You can leave any individual questions blank that you feel unable to answer for any reason.

Your GP will be informed that you are taking part in this study. If you have reported currently feeling distressed, with your permission, **we will send a letter to your GP informing your doctor about your experience of distress in our study**. **Your GP will decide what the best treatment for how you are feeling is.** We will encourage you to talk to your GP if you are concerned with how you are feeling.

10. What if I change my mind about taking part?

You can change your mind and stop taking part in the study at any time, without explaining why. If you stop taking part we will destroy any documents with your name or address on them. We will keep all questionnaires already completed without your name or address on them.

11. What if there is a problem?

If you experience a problem or have any worries about the study you can contact Dr. Matei Vladeanu on 07872 160262. We will do our best to help you or answer any questions.

If you want general advice about taking part in research or you would like to complain formally through the NHS you can contact the Patient Advice and Liaison Service at King's College Hospital at Denmark Hill, London, SE5 9RS or by telephone on 020 3299 3601 or e-mail at kch-tr.PALS@nhs.net.

If during the research something goes wrong that hurts you and this is due to someone's negligence, then you may have grounds for a legal action for compensation against King's College London, but you may have to pay your legal costs. However, we think it is unlikely that anything will go wrong in this way.

12. Who is funding this research?

This research is funded by:

- The Institute of Psychiatry, King's College London

13. Who is organising this research?

The research is led by Matei Vladeanu. He is a doctoral student at the Institute of Psychiatry, King's College London. Matei is supervised by:

- Dr. Lidia Yágüez (Lecturer in Clinical Psychology; Academic Director of the D.Clin.Psy Training Programme at the Institute of Psychiatry, King's College London; and Honorary Clinical Psychologist/Neuropsychologist at King's College Hospital NHS Foundation Trust).

- Dr. Keyoumars Ashkan, Consultant Neurosurgeon and Reader in Neurosurgery, King's College Hospital NHS Foundation Trust.

14. Who has reviewed the research?

This research has been examined by an independent group of people called a Research Ethics Committee. This group protects your safety, your rights, well-being and dignity.

15. Would you like to take part in this research?

If you would like to take part in this research study or have any further questions please contact Matei Vladeanu:

3rd Floor, Addiction Sciences Building
4 Windsor Walk
Denmark Hill, SE5 8AF
Tel: 07821 740 833
matei.vladeanu@kcl.ac.uk

King's College Hospital NHS Foundation Trust | Institute of Psychiatry at The Maudsley | King's College London

Patient Identification Number for this trial:

CONSENT FORM

Title of Project: **Social Cognition and Facial Emotions**

Name of Researcher: **Dr Matei Vladeanu**

Please initial all boxes

1. I confirm that I have read and understand the information sheet dated 01.11.2013 (version 002) for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily. ☐

2. I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason, without my medical care or legal rights being affected. ☐

3. I understand that relevant sections of my medical notes and data collected during the study may be looked at by a member of the research team (Dr Matei Vladeanu) or from the NHS Trust, where it is relevant to my taking part in this research. I give permission for these individuals to have access to my records. ☐

4. I agree to my GP being informed of my participation in the study if I report feeling emotionally distressed or if I score within the clinical range on a measure of emotional distress completed as part of this research. ☐

5. If I lose capacity to give consent during the study, I agree that the data already collected with consent can still be used for this research. No further data will be collected or any research procedures carried out. ☐

6. I agree to take part in the above study. ☐

Name of Participant	Date	Signature

Name of person taking consent	Date	Signature
Dr Matei Vladeanu		

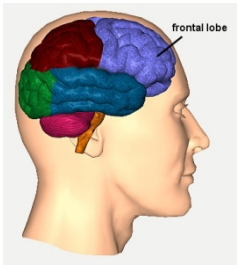
King's College Hospital NHS Foundation Trust | Institute of Psychiatry at The Maudsley | King's College London

Social Cognition and Facial Emotions:

Information Sheet

1. What is the purpose of this research?

People can form impressions of other people very quickly, usually based on their appearance and the emotion they show on their faces. For example, if someone appears relaxed and is smiling, it is probably okay to approach and start a conversation. On the other hand, if someone is frowning and appears tense or angry, it may not be the best time to approach him/her and try to make conversation. Psychological studies have shown that the frontal part of the brain (also known as the Frontal Lobes) plays a major role in making these social judgments. The Frontal Lobes (shown in purple in the picture on the right) are one of the four main lobes or regions of the brain. They are positioned at the very front region of the brain and are involved in lots of essential functions such as: movement, decision-making, problem solving, and planning. Very importantly for this study, the Frontal Lobes are involved in the ability to recognize future consequences resulting from current actions, to choose between good and bad actions (or better and best), interpret subtle emotions (such as guilt or admiration) and suppress socially unacceptable responses (such as laughing at someone who is showing saddness and is tearful).



Some people find it very easy to form accurate impressions of people they come in contact with, whereas others find it more difficult. Some people find it difficult to form accurate impressions after brain surgery in the frontal part of the brain. We would like to understand the consequences of this type of surgery on the ability to form accurate impressions of others and develop new ways of helping people who had this type of surgery. However, we need to find out how healthy volunteers (people who did not have surgery to the frontal part of the brain), such as yourself, are able to from impressions of someone else. We are also interested to find out how accurately you can interpret simple facial expressions (such as happiness, anger, sadness) or more complex ones (such as guilt, admiration or thoughtfulness). Also, we are interested to see whether you consider some people more approachable or trustworthy than others.

2. Why have you asked me to take part?

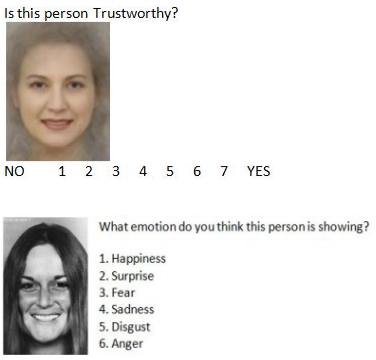
We have asked you to take part in this study because you volunteered to take part in research at King's College London and made your contact details available through "Mindsearch" and/or other public database. You do not need to take part if you don't want to.

3. What will I be asked to do?

We will ask you to complete a series of short tasks that measure thinking processes such as concentration, memory, planning and problem solving.

We will also ask you to look at some pictures of people you have never met before and make some judgements such as:

- How approachable do they seem to you?
- How trustworthy do they seem to you?
- What emotion do you think they are expressing?



Possible answers are provided for you, you only have to choose the one that seems the most accurate. It is important to note that there are **no right or wrong answers**! The pictures will be presented on a computer screen, so it is important to have your glasses with you (if you normally wear glasses).

Before we ask you to complete the tasks and answer these questions, you will need to sign a consent form to say that you would like to take part.

4. How long will this research take?

It will take a maximum of 2 hours to complete all the tasks and answer all the questionnaires. You do not have to answer them all at one time. You can take as many breaks as you need.

5. Do I have to take part?

No. Taking part in this research is your choice. You do not need to take part if you do not want to.

6. Where do I need to go?

We would like to invite you to attend an appointment at King's College London. We will be able pay you £10 for taking part in this research.

7. What will you do with my answers?

You will be given a code, so that your answers to questions are anonymous. They will be kept in a locked filing cabinet in a secure office at King's College, London. Only the researchers involved in this study will know your name and be able to identify you.

If you are interested, we can send you a summary of what we find. The findings will also be written up as part of a doctoral thesis and described in a scientific paper. Your name or any personal information will not be shown in any reports.

We will keep all questionnaires for 10 years. Then they will be destroyed securely by shredding any paper records and permanently deleting information held on computer.

8. Are there any benefits for me?

This research may not help you directly. The aim of our research is to understand how well people form impressions of others and how accurately they can interpret emotions shown on people's faces after they have had surgery on the front part of the brain. By taking part in this research you will be helping us to achieve this.

9. Will there be any risks involved?

We do not think that you will be exposed to any risks if you take part in this study. You do not have to answer questions that you feel uncomfortable answering. You can leave any individual questions blank that you feel unable to answer for any reason. We will encourage you to talk to your GP if you are concerned with how you are feeling.

10 .What if I change my mind about taking part?

You can change your mind and stop taking part in the study at any time, without explaining why. If you stop taking part we will destroy any documents with your name or address on them. We will keep all questionnaires already completed without your name or address on them.

11. What if there is a problem?

If you experience a problem or have any worries about the study you can contact Dr. Matei Vladeanu on 07872 160262. We will do our best to help you or answer any questions.

If during the research something goes wrong that hurts you and this is due to someone's negligence, then you may have grounds for a legal action for compensation against King's College London, but you may have to pay your legal costs. However, we think it is unlikely that anything will go wrong in this way.

12. Who is funding this research?

This research is funded by:

- The Institute of Psychiatry, King's College London

13. Who is organising this research?

The research is led by Dr. Matei Vladeanu. He is a doctoral student at the Institute of Psychiatry, King's College London. Matei is supervised by:

- Dr. Lidia Yágüez (Lecturer in Clinical Psychology; Academic Director of the D.Clin.Psy Training Programme at the Institute of Psychiatry, King's College London; and Honorary Clinical Psychologist/Neuropsychologist at King's College Hospital NHS Foundation Trust).
- Dr. Keyoumars Ashkan, Consultant Neurosurgeon and Reader in Neurosurgery, King's College Hospital NHS Foundation Trust.

14. Who has reviewed the research?

This research has been examined by an independent group of people called a Research Ethics Committee. This group protects your safety, your rights, well-being and dignity.

15. Would you like to take part in this research?

If you would like to take part in this research study or have any further questions please contact Dr. Matei Vladeanu:

3rd Floor, Addiction Sciences Building
4 Windsor Walk
Denmark Hill, SE5 8AF
Tel: 07821 740 833
matei.vladeanu@kcl.ac.uk

King's College Hospital NHS Foundation Trust | Institute of Psychiatry at The Maudsley | King's College London

Healthy Volunteer Identification Number for this trial:

CONSENT FORM

Title of Project: **Social Cognition and Facial Emotions**

Name of Researcher: **Dr Matei Vladeanu**

Please initial all boxes

1. I confirm that I have read and understand the information sheet dated 24.04.2014 (version 002) for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily. ☐

2. I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason, without my medical care or legal rights being affected. ☐

3. I agree to take part in the above study. ☐

Name of Participant	Date	Signature

Name of person taking consent	Date	Signature

Part III

SERVICE EVALUATION PROJECT

A REVIEW OF DEMOGRAPHIC DIFFERENCES IN ENGAGEMENT WITH PSYCHOLOGY SERVICES AT SHARP (SOCIAL INCLUSION, HOPE AND RECOVERY PROJECT)

Matei Vladeanu

Supervised by: Dr. Helen Waller, Clinical Psychologist, SHARP

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1. Abstract

Several governmental reports have described significant disparities in access to and experiences of mental health care and treatment outcomes between ethnic minority groups and the majority white community in the UK. (Inside Outside, Government Report 2003; Commission for Healthcare Audit and Inspection, 2005). The Equality Act (2010) requires public services to take an active role in eliminating unlawful discrimination and promote equality of opportunity between different groups. This service project evaluated access to and drop-outs from psychological therapies across different ethnic groups for the Social inclusion, Hope and Recovery Project (SHARP) team, in the psychosis CAG within Lambeth (South London and Maudsley NHS Trust).

Quantitative data were collected from referrals to SHARP between January 2012 and July 2013 regarding clients who were offered psychological therapy but declined the offer and disengaged with the service, clients declined psychological therapy but accepted and engaged in other (non-psychological) therapies, clients who accepted the offer and then engaged in therapy and finally clients who accepted the offer of psychology, but later dropped out of therapy. Qualitative data was gathered by means of brief telephone interviews from clients from a range of ethnic backgrounds who were referred for psychology. A total of 21 clients were contacted and invited to take part in the brief feedback interview; 13 of these were clients who had dropped out of therapy, five of which declined the interview; eight were clients who has engaged with psychology and all agreed to take part in the interview. The data presented is from eight clients who dropped out of therapy and eight clients who engaged with therapy.

Results suggest that good insight into the referral generally facilitated engagement in all ethnic groups. On the other hand, unexpected events in the clients' lives, such as bereavement and separation were found to be among the reasons for abandoning therapy mainly in clients from a Black ethnic background. It also emerged that clients who expressed doubts about their cognitive abilities (which they perceived as inadequate for psychological therapy) were more likely to drop out, regardless of their ethnic background.

2. Introduction

2. 1. Prevalence of Psychosis in BME and Ethnic Minority Populations

Many studies have reported comparatively higher rates of psychosis in BME in the UK, ranging from two to twelve times higher than for the White British population (e.g. Morgan, Dazzan and Morgan, 2006; Keating, 2007; Kirkbridge,Barker, Cowden, Stamps, Yang, Jones and Coid, 2008, Fung, Bhugra & Jones, 2009). It is now generally agreed that socioeconomic factors play a crucial role in the onset and subsequent relapses of psychotic disorder (Cantor-Graae & Selten, 2005, Cantor-Graae, 2007, Kirkbridge et al., 2008, Pedersen & Cantor-Graae, 2012, Cantor-Graae &, Pedersen 2013). Further, meta-analytic reviews of the literature have suggested that a history of migration is an important risk factor for psychosis. For example, Cantor-Graae and colleagues (Cantor-Graae & Selten, 2005; Cantor-Graae, 2007) found that first generation black migrants who moved to counties with white majority populations (such as countries in Western Europe), have on average twice the risk of developing psychosis in comparison to the indigenous White population. Surprisingly, they found that the risk increases for second generation BME migrants, suggesting that, perhaps a complex interaction between biological, socioeconomic, and cultural factors may be at play. For example, it has been suggested that migrants from a BME background who are exposed to a crowded and unfamiliar urban environment, in a different culture based on high levels of social competition, may have experienced high levels of social isolation, economic deprivation and social defeat (Cantor-Graae, 2007).

Discrimination also plays an important role to the migrant's experience of social defeat, and may exacerbate social isolation, especially for second generation migrants (i.e. British born people from a BME background) who may feel even more humiliated by this "outsider" status (Selten and Cantor-Graae, 2005). Long term exposure to social defeat may cause biological changes to the dopamine system in the brain, thus explaining the interaction between the social and biological factors that contribute to the aetiology of psychotic disorder (Selten and Cantor-Graae, 2005; Selten, van der Ven, Rutten & Cantor-Graae,

2013). It is also important to mention that although rates of psychosis seem to be considerably higher for people from African and Caribbean communities living in the UK than for the White British population, rates in the Caribbean and Africa are comparable to the overall rate in England (Morgan et al., 2006). This seems to add further support to the idea that socioeconomic and environmental factors are at least as important as the genetic and biological factors with regard to the risk of developing psychotic disorder.

It has been suggested that strong identification with a BME group subjected to discrimination and social disadvantage may increase the risk for developing psychosis (Reininghaus et. al., 2010). Even though the authors argue that the increase in risk is mainly because of the perceptions of disadvantage and not because of ethnic identity, it remains unclear whether cultural differences between BME and White British cultures also play a part in the formation of these perceptions. In this context of perceived disadvantage and discrimination, it may be very difficult to accept help from a predominantly white health service, with specific Western based treatments and outcome measures.

Similarly to the rest of the UK, South London also shows disproportionately high rates of psychosis for service users belonging to the African and Caribbean communities in comparison to those from a White background (Castle, Wessely, Van Os, & Murray, 1998). According to the 2011 Census, Lambeth is one of the most densely populated (over 304000 people) and ethnically diverse boroughs in London (25.9% BME African and Caribbean; 4.1% White and BME mixed background; 39% White British, etc). Earlier surveys have found significantly higher rates of unemployment, crime rate and psychosis incidence than the national average (Garety and Rigg, 2011).

2. 2. Access to psychological treatment for service users from a BME background

The National Institute for Health and Clinical Excellence (NICE) recommends that psychological interventions (Cognitive Behavioural Therapy for psychosis (CBTp)) should be offered to all patients as it has been shown to be effective in

reducing hospitalisation and distress associated with the positive symptoms of psychosis (NICE, 2009).

Efforts have been made to increase access to generic psychological treatment nationally (e.g. Improving Access to Psychological Therapies - IAPT). However, studies have consistently suggested that service users from a BME background (especially black males of African and Caribbean origin) are more likely to refuse psychological intervention or drop out before the end of the treatment (e.g. Morgan, 2009, Sainsbury Centre for Mental Health, 1998). A previous clinical audit conducted in the Psychosis CAG (South London and Maudsley NHS Trust) across the borough of Croydon, reported that 14% fewer BME clients completed a full course of psychological therapy (CBT for psychosis), in comparison to White clients (McGourty, 2011). This audit also reported that factors including level of deprivation and language preference were also important to consider as predictors of therapy take up, but did not find significant effects of age and gender. However, since an interaction between gender and ethnicity has been previously reported in the literature, with males from BME backgrounds displaying slightly higher risk of developing psychosis than females (e.g., Kirkbridge et al., 2008, Morgan, 2009) this audit aimed to investigate the effect of gender as well as ethnicity on engagement with Psychology services.

The present audit aims to build on this previous work, within one local NHS service within the Psychosis CAG; the SHARP team.

SHARP is a multidisciplinary tertiary service, offering multiple recovery-focused treatment pathways. These include:

- **Occupational therapy(OT):**
    - ‘Social inclusion therapy’: Around 20 individual sessions with an occupational therapist, aiming to promote social inclusion and engagement with the local community.
    - ‘Healthy living group’: A 16 week group programme aiming to educate clients on aspects of healthy living and to teach practical healthy cooking skills.

- **Physical Therapy (PT):**
    - Gym: weekly 1 hour group, not time-limited.
    - Aqua aerobics: weekly 1 hour group, not time-limited.
    - Football: weekly 1 hour group, not time=limited.
- **Psychological Therapies (PSY):**
    - CBT for psychosis: Following NICE-recommended guidelines of 16-20 weekly sessions, where possible.
    - Family Interventions: Following NICE-recommended guidelines of meetings for at least 6 months, where possible.
    - Hearing Voices Group: Comprises 6 weekly group sessions.

Additionally, at the time of this audit SHARP offered several pilot pathways such as Mindfulness and Acceptance and Commitment Therapy for Recovery (ACT).

2. 3. Service evaluation objectives

The present audit aims to evaluate and explore:

a) The breakdown of ethnic backgrounds and gender of all referrals to the SHARP team, with an emphasis on referrals to psychology.
b) The number of and distribution of engagement, non-engagement and drop out from psychology, based primarily on ethnicity, and also on gender.
c) The possible reasons for non-engagement, drop-out, and engagement from psychological therapy across different ethnic backgrounds.

3. Methods

Audit approval for the project was granted from the Clinical Governance team within the Psychosis CAG (Appendix 1).

Data were collected from referrals to SHARP between January 2012 and July 2013. The SHARP team accepts referrals from both MAP and Psychosis

Clinical Academic Groups. For the purpose of this audit, only those clients from the psychosis CAG were included.

3. 1. Part One: Data on Referrals to the SHARP team

Referral data was collected from the team's database, including total number of referrals, ethnic backgrounds, gender and the type of therapy they were referred to. The data were collapsed into three main categories (*White Background*: comprising White British, Irish and other White background; *Black Background*: comprising Black African, Black Caribbean, Other Black Background and Mixed Black-Other background, and *Other Background*: comprising all other recorded backgrounds, such as Asian and mixed Asian background etc.). The same procedure (e.g. collapsing data as described above) was applied to the Census data (2011).

3. 2. Part Two: Data on Psychological Therapy

Data was gathered from team notes and team members regarding clients who:
i) were offered psychological therapy but declined the offer and disengaged with the service
ii) declined psychological therapy but accepted and engaged in other (non-psychological) therapies, such as physical or occupational therapies
iii) were referred for psychology, accepted the offer and then engaged in therapy
iv) those who accepted the offer of psychology, but later dropped out of therapy.

Cases were classed as “engaged in therapy” or “completed therapy” based on the reports of their respective therapists. Cases were counted as “dropped out” if clients did not attend at least three consecutive sessions, or if they let the therapist know they do not wish to continue. The drop out cases were then further examined in terms of whether they a) either completely disengaged with the service (e.g. not engaged with any of the other therapies offered by SHARP) or b) engaged in other (non psychological) interventions (physical therapy or occupational therapy).

Information was collected from six Clinical Psychologists and one CBT therapist providing individual or group therapy (Hearing Voices Group) for psychosis as well as from the Occupational Therapists and Physical Therapists at SHARP in Lambeth. Six staff were from a white ethnic background (three male; three female) and one member of staff (female) was from a mixed White/Black British background. The data collected from them will be presented according to the total numbers of referrals, and by ethnicity and gender.

3. 3. Part Three: Qualitative Data

Qualitative data was gathered by means of brief telephone interviews. We aimed to gather information from clients from a range of ethnic backgrounds (e.g. BME and white) who were referred for psychology. This included clients who subsequently dropped out of psychological therapy (both those who have remained engaged with another intervention at SHARP, as well as those who completely disengaged from the team) and a smaller number of clients who engaged with psychology for comparison. A total of 21 clients were contacted and invited to take part in the brief feedback interview; 13 of these were clients who had dropped out of therapy, five of which declined the interview; eight were clients who has engaged with psychology and all agreed to take part in the interview. The data presented is from eight clients who dropped out of therapy and eight clients who engaged with therapy. The answers to the questions were written down verbatim. Then the data was explored for themes on all participants, as well more specifically according to the participants' different ethnic backgrounds and gender. Summaries of the main themes are presented in the results section.

3. 3. 1. Interview Schedule:

The interview schedule was developed in conjunction with the team. The main themes were loosely based on areas of interest, given previous literature in this area and the findings from the previous audit. The interview focused on several key areas (please refer to Appendix II for the complete interview script), which are summarised in Table 1.

Theme	Example Question	Hypothesis
Referral understanding	Why do you think you were referred?	Low insight into their condition may have affected engagement.
Reasons for engagement or disengagement	How did you find the initial sessions? Did you have any concerns? Were there any other things going on in your life at the time? Was it anything to do with the service? Did you have previous experience with psychology? Did the sessions seem to fit with your cultural or spiritual needs? Did you feel your background and culture were adequately attended to? Did you feel your spiritual needs were taken seriously? Do you think something else would have been better suited for your needs?	If clients had specific concerns about therapy (e.g. effectiveness) which were not addressed in the initial session it may have affected subsequent engagement. If sessions did not fit with the client's cultural and spiritual needs they would be more likely to drop out.
Social support network and its influence on engagement	What do your friends or relatives think about someone seeing a psychologist? Where would you usually go for help?	Social stigma around being engaged with mental health services may have hindered engagement.

Table 1: Key areas within the interview schedule.

First, the clients were asked about their understanding of their referral to psychology. It was hypothesised that the client's motivation to engage may have been linked in some way to their insight into their condition as well as their understanding of our services.

Then the clients were asked whether they were able to attend any sessions. The clients who attended at least one session were asked about their impression of the initial sessions. All clients (whether they attended any session or not) were asked about the reasons that made it hard to attend. Given that the previous literature has suggested a multitude of reasons why service users from a BME background' may not attend, such as perceptions of disadvantage and inferiority (Reininghaus et al. 2010), cognitive difficulties (Garety et al, 2001;

Kirkbride et al, 2008) or perceived cultural and spiritual differences (e.g. Rathod et al, 2010, 2013), and some of the interview questions were aimed at these themes. However more open questions were also included, such as "*Were there any other things going on in your life at the time*?" or "*Did you have any concerns?*", which were intended to give the clients space to express themes we did not anticipate.

Finally, there were also questions targeted at the clients' wider support group (such as family or friends) and their understanding of psychology and psychotherapy. There is ample evidence in the literature suggesting that Service users from a BME background (especially from migrant backgrounds) are exposed to discrimination and social isolation (e.g. Selten and Cantor-Graae, 2005; Cantor-Graae, 2007, Selten, et al., 2013). Therefore the purpose of those questions was not only to get an idea about the client's social support network, but also to find out whether peer pressure or stigma associated with attendance to mental health services may be reinforced or attenuated by this social network.

3. 4. Ethical considerations

In line with the audit approval granted for this project and under the Data Protection Act all data files (Microsoft Excel or any other format) were password protected and sent via email on the SLaM Email system. No information was transferred outside of this system. The final database produced as part of this audit did not contain names or any other personal identifier information, only gender, ethnicity, type of therapy and outcome. This database was also password protected.

4. **Results**

4. 1. Part One: Data on Referrals to the SHARP team

A total of 272 (144 females, 128 males) referrals were recorded between 01/01/12 and 01/07/2013. Figure 1 shows the distribution of referrals within SHARP as well as a breakdown of outcomes after therapy was offered for psychology.

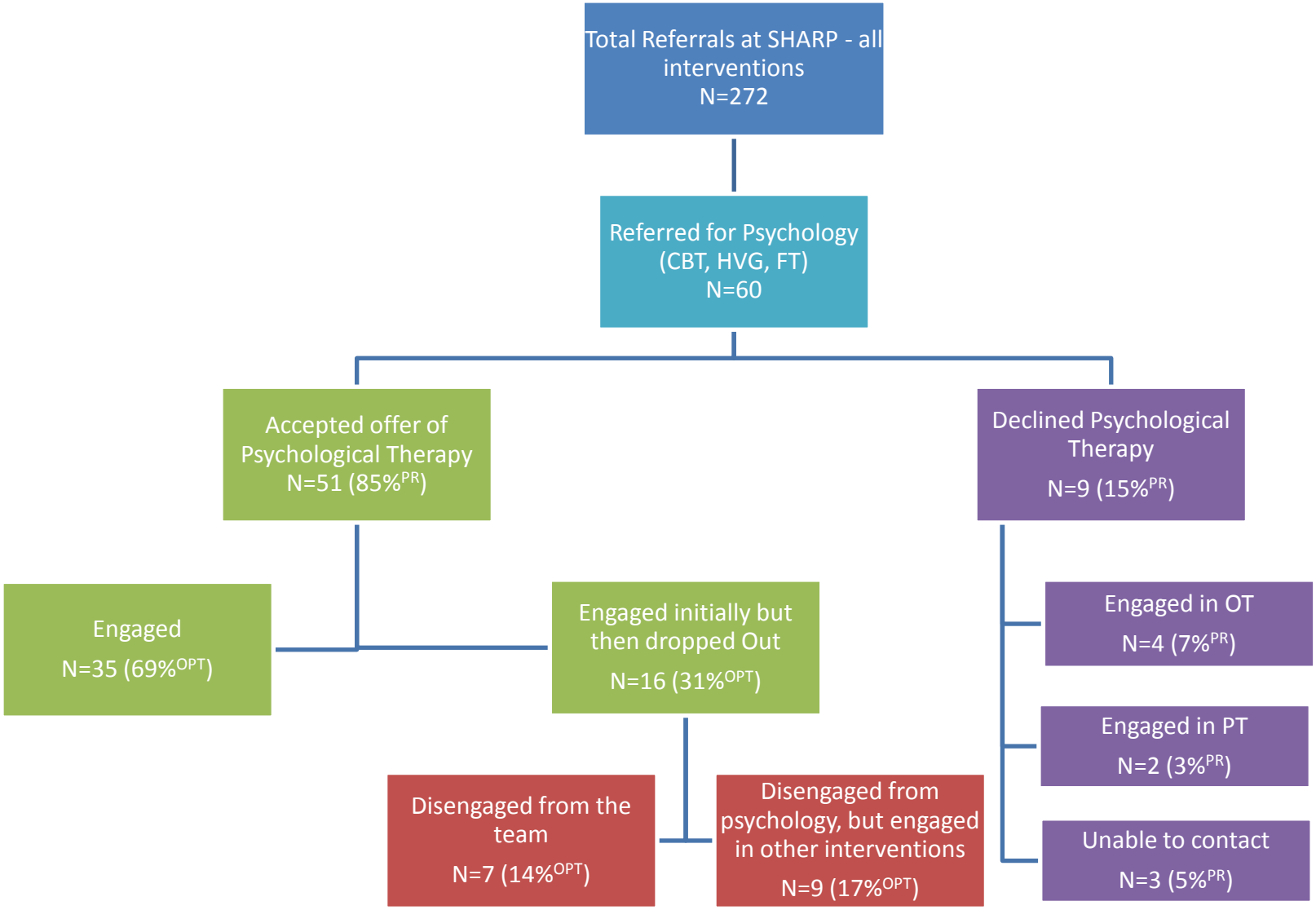

Figure 1: Referrals to SHARP over 18 months: from 01/01/2012 to 01/07/2013.

OPT Represents percentage of clients who were offered psychological therapy
PR Represents percentage of clients out of total psychology referrals

Total SHARP Referrals by Ethnicity: When comparing the referral rates by ethnicity with the overall Lambeth demographic data (taken from the 2011 census) the pattern of referral seems to indicate that comparatively higher numbers of service users from a BME background were referred to SHARP than clients belonging to the White or other ethnicities (see Figure 2). This is consistent with previous prevalence studies which reported higher rates of psychosis in clients from BME backgrounds in comparison with clients from White and other ethnic backgrounds (e.g. Morgan, Dazzan and Morgan, 2006; Keating, 2007; Kirkbridge,Barker, Cowden, Stamps, Yang, Jones and Coid, 2008, Fung, Bhugra & Jones, 2009).

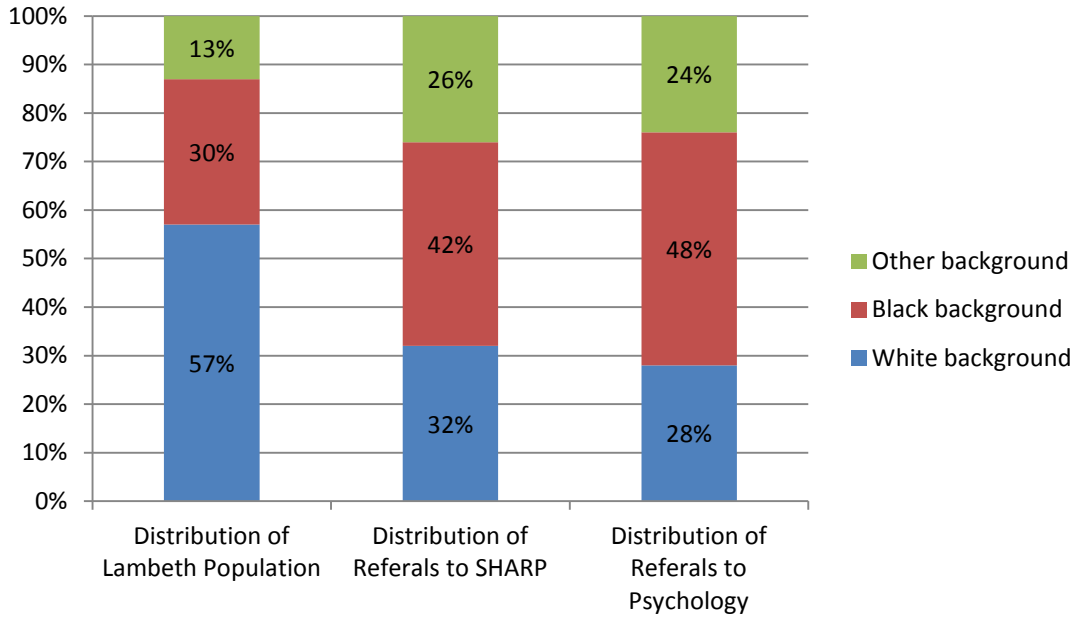

Figure 2: Distribution of referrals in comparison to population distribution in Lambeth.

Total SHARP Referrals by Gender and Ethnicity: When looking at gender, there were no notable differences in referral rates, with approximately equal male (47%) to female (53%) referrals to SHARP.

4. 2. Part Two: Data on Psychological Therapy

As displayed in Table 1, 60 clients (35 females, 25 males) were referred for psychological therapy (CBTp, Hearing Voices Group and Family Therapy) within the audit time period.

Total Psychology Referrals by Ethnicity: Almost half of referrals (48%) being service users from a BME background, with others from a white background (52%).

Total Psychology Referrals by Gender and Ethnicity: There seemed to be slightly more females (58%) referred for psychology than males (42%) within the timeframe of this audit. This pattern was similar across all ethnic backgrounds (see Table 2).

	Male	Female	**Total (%)**
White	7	10	**17 (28%)**
Black	12	17	**29 (48%)**
Other	6	8	**14 (24%)**
Total (%)	**25 (42%)**	**35 (58%)**	**60 (100%)**

Table 2: Overall referrals to psychology by ethnicity and gender.

As displayed in Figure 1, of the 60 clients referred for psychology, 51 were classed as taking up the offer of psychological therapy, whereas 9 declined the offer, following an initial team assessment. Of the 51 who accepted the offer, 35 people went on to complete a course of psychological therapy, and 16 started therapy but were classed as subsequently dropping out.

Analysis of clients who declined the offer of psychological therapy (n=9):
There were nine clients (4 Black females, 3 Black males, 2 White males) who, after assessment declined psychological therapy, but were interested in other therapies (see Table 3). Four clients (3 Black females and 1 White male)

engaged in occupational therapy and two clients (1 Black male and 1 White male) in physical therapy. The remaining three (1 Black female and 2 Black male) clients were not in contact with SHARP at the time of the audit and could not be contacted throughout the time this audit was conducted. It was unclear whether they re-engaged with the service or dropped out.

Engagement Status	Ethnicity	Total (%)	Male	Female
Engaged in Occupational Therapy	White	1 (11%)	1	0
	Black	3 (34%)	0	3
	Other	0 (0%)	0	0
	Total	**4 (7%*)**	**1 (11%)**	**3 (34%)**
Engaged in Physical Therapy	White	1 (11%)	1	0
	Black	1 (11%)	1	0
	Other	0 (0%)	0	0
	Total	**2 (3%*)**	**2 (22%)**	**0 (0%)**
Unable to contact (no data)	White	0 (0%)	0	0
	Black	3 (34%)	2	1
	Other	0 (0%)	0	0
	Total	**3 (5%*)**	**2 (22%)**	**1 (11%)**

Table 3: Distribution of clients who refused psychology based on gender and ethnicity. (* represents percentage of total referrals to psychology).

Analysis of clients who accepted the offer of psychological therapy (n=51): The data on those who accepted the offer of psychological therapy are summarised in Table 4, according to ethnicity and gender.

Engagement Status	Ethnicity	Total (%)	Male	Female
Offered Psychology	White	13 (25%)	5	8
	Black	33 (61%)	9	22
	Other	7 (14%)	2	5
	Total	**51 (85%*)**	**16 (31%)**	**35 (69%)**
Engaged with Psychology	White	10 (29%)	4	6
	Black	19 (54%)	7	12
	Other	6 (17%)	2	4
	Total	**35 (69%**)**	**13 (37%)**	**22 (63%)**
Dropped Out	White	3 (19%)	1	2
	Black	12 (75%)	2	10
	Other	1 (6%)	0	1
	Total	**16 (31%**)**	**3 (19%)**	**13 (81%)**

Table 4: Overall engagement with psychology by ethnicity and gender.
(* represents percentage of total referrals to psychology; ** represents percentage of clients who were offered psychological therapy)

Table 4 shows that the majority of clients referred to psychology were offered psychological treatment and accepted it (85% of total referrals to psychology). Out of the clients who were offered psychology, the majority (69%) engaged in the treatment. When looking at engagement data by ethnic group, 77% of White clients who were offered psychological therapy engaged in it (10 clients out of 13). A similarly high level of engagement (86%) was observed for clients belonging to the "Other" group whereas for clients belonging to the Black group, engagement was somewhat more reduced (58%), but still representing more than half of the clients offered psychological interventions. As it can be seen in Figure 3, there were more females in our data than males, and this is reflected in the engagement and dropout rates.

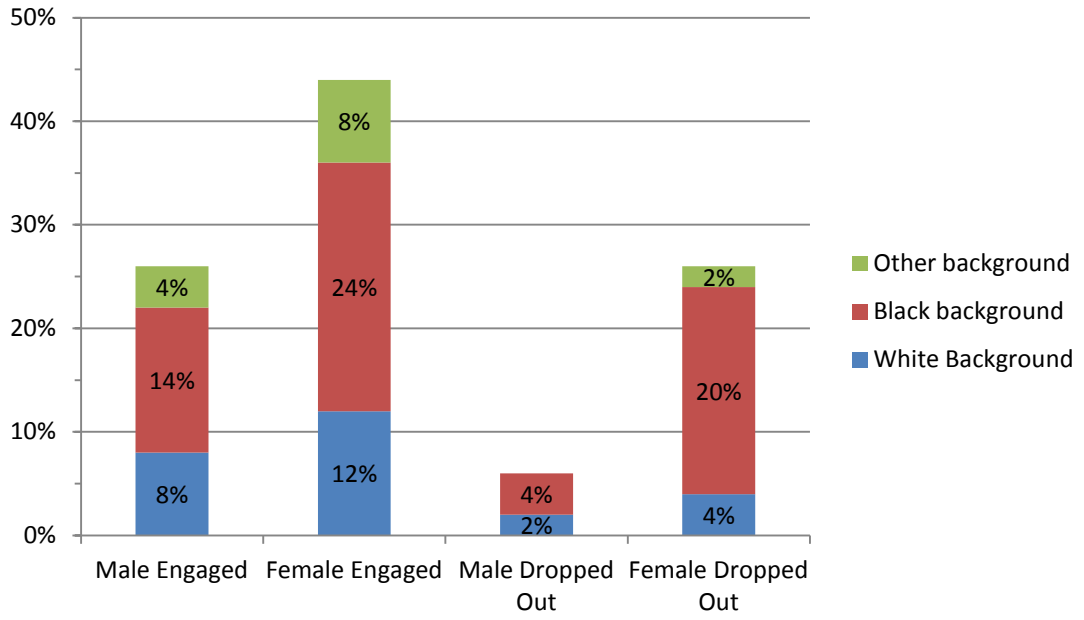

Figure 3: Engagement with Psychology by ethnic group and gender

Analysis of clients who were offered psychological therapy but dropped out (n=7): Out of the clients who dropped out (31% the psychology referrals), 7 clients disengaged completely from all SHARP services, but nine engaged in other interventions (e.g. 6 in OT and 1 in PT, 2 in both OT and PT). The data are presented in Table 5, broken down according to ethnicity and gender.

Engagement Status	Ethnicity	Total (%)	Male	Female
Completely disengaged	White	2 (29%)	1	1
	Black	5 (71%)	0	5
	Other	0 (0%)	0	0
	Total	**7 (14%*)**	**1 (14%)**	**6 (86%)**
Engaged in other interventions	White	1 (11%)	0	1
	Black	7 (78%)	2	5
	Other	1 (11%)	0	1
	Total	**9 (17%*)**	**2 (22%)**	**7 (78%)**

Table 5: Distribution of "drop out" clients based on gender and ethnicity.
(* represents percentage of total referrals to psychology)

Psychology Referrals, according to ethnic background: When examining the ethnic distribution of engagement with Psychology services it can be noted that higher percentages of clients belonging to the Black group dropped out of therapy (approx 24% combining total disengagement and engagement with other services only) in comparison to White (approx 6%) and 'other' ethnic groups (2%). However, this result should be interpreted with caution, taking into account the fact that 48% of referrals to psychology were of service users from a Black background' and also that 61% of clients who were offered psychological therapy were from Black backgrounds. Therefore, considering that the three ethnic groups are unequal in numbers, the data was looked at in terms of the proportion of engagement/disengagement within each ethnic group.

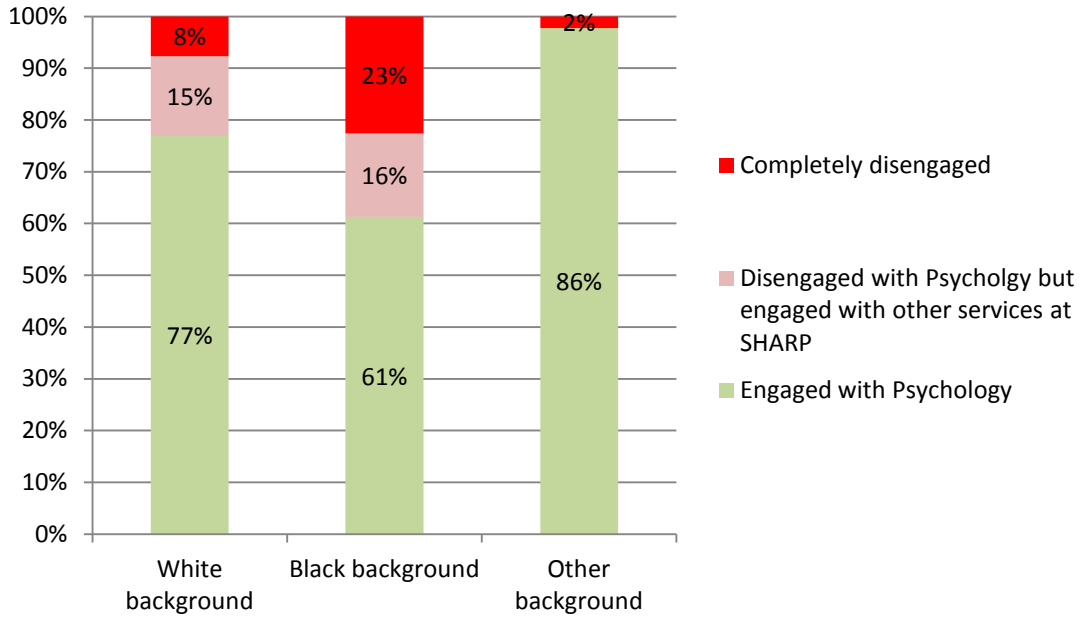

Figure 4: Ethnic distribution (%) of engagement data with Psychology services at SHARP. The data represents the proportion of engagement/disengagement within each ethnic client group.

As it can be seen in Figure 4, some clients from a Black ethnic background disengaged fully with the team (approx 23%), whereas others continued treatment using a different type of intervention (approx 16%). These percentages are broadly similar with the ones observed in the White service user group. Clearly the best engagement is seen in the "Other" group, but this

was based on a very small number of referrals (7 clients in total). These quantitative data, however, do not shed any light on the reasons why clients disengaged with psychology

4. 3. Part Three: Qualitative data - Exploring reasons for engagement, non-engagement and drop-out from psychological therapy.

A total of 16 telephone interviews were conducted with clients who had agreed to a psychology referral: 8 were clients who dropped out (7 from Black backgrounds and 1 from White group) and 8 clients who engaged with psychology, in order to provide a comparison (6 Black and 2 White), from both White and Black backgrounds. Unfortunately despite several attempts we were unable to contact any of the nine clients who declined the offer of psychological therapy.

Given the limited amount of data, a formal thematic analysis was not possible. Nevertheless, a summary of the data is provided below.

4. 3. 1. Understanding of the referral

Therapy Drop-Out Clients: Almost all clients who dropped out (regardless of ethnic group) were not able to explain their referral (e.g. "*I don't know*", "*Because the doctor said so*") or gave brief answers to this question, finding it difficult to elaborate (e.g. *"Because I'm ill and I need help"*). Only one client (who was from a Black background) was able explain in more detail: *"Because I hear these voices and no one has been able to help me. I mean the nurses and all the people at the hospital. I was referred to psychology so I can talk to someone about all the things I could not say to other people... like stuff about my voices ... and other stuff people don't understand"*.

The majority of the clients who did not engage seemed to have a limited understanding of their referral as well as the role of psychology. Given the small numbers, it is not possible to comment on differences across ethnicities, but from the limited data we collected, the one white client showed similar responses to the service users from a Black background.

Engaged Clients: In contrast, all clients who engaged with psychology were able to discuss their referral, albeit with variable amounts of detail. These clients spoke about their difficulties with psychotic symptoms, and most importantly showed a greater understanding of the role psychology in helping them cope with their difficulties. An illustrative example is taken from the transcript of one client, from a Black background: *"I was referred because my life was in tatters and I really needed help. I used to live in fear of my voices day and night... I feared people ... bad people would come after me. It was really bad. I think the worst part was that I thought I was the only one in the world who felt like that, and I could not tell anyone. My understanding of my referral was that the psychologist was the person I could talk to about all these things ... and they would listen to me ... and try to help me, not think I'm barking mad and need to be locked away. It's hard when you have no one you trust".*

4. 3. 2. Reasons for drop-out

The main theme that emerged from this section of the interview was related to "other things going on in your life" (Question 4, 2nd prompt).

Therapy Drop-Out Clients: Clients who did not engage reported significant events happening in their life at the time when they were offered psychological therapy or when they had already started the therapy (1 or 2 sessions). Most of them (6 clients from Black ethnic backgrounds) stated that they had significant family problems (e.g. bereavement, separation, issues regarding immigration status of close relatives). The remaining 2 clients (1 from Black, 1

from White ethnic background) also reported they had multiple significant events in their life but they were not specifically related to the family.

Another interesting theme emerging from this section of the interview was around the concerns clients had. Most clients (4 from Black, 1 from White ethnic backgrounds) reported no concerns. However, one client from Black ethnic background reported a fear of *"being locked up again"*, whereas another client (also from a Black ethnic background) expressed doubts about their cognitive abilities, which they perceived as inadequate for successfully engaging in psychological therapy: *"I'm just not smart enough for this sort of thing..."*. Finally, another client from a Black ethnic background who engaged in other therapies at SHARP after disengaging with psychology, reported concerns regarding the effectiveness of talking therapies *"I won't get better by talking"*. Interestingly, no client from the "drop out" group reported any prior contact with psychology before being referred to SHARP.

Engaged Clients: Notably, only 50% of the clients who engaged with the service reported significant events in their lives at the time of the referral (2 from Black and 1 from White ethnic background). Also, all these clients (regardless of ethnic backgrounds) reported no current concerns, although one client (Black ethnic background) spontaneously recalled they had *"some doubts"* regarding talking therapies prior to meeting their therapist. This may simply indicate elevated levels of hope in this group in comparison to drop out clients. It may also be possible that clients who engaged might have had similar concerns before experiencing psychological therapy but changed their mind in the light of their experiences. Two clients from the "engaged" group reported prior contact with psychology, but they were actually referring to the mindfulness or ACT groups at SHARP.

All Clients: Importantly all clients interviewed (from both drop out and engaged groups) reported that their spiritual or cultural beliefs were adequately attended to. Also, it is worth noting that none of the clients reported any concerns regarding the service.

4. 3. 3. Social support network and its influence on the decision to attend psychotherapy

All Clients: Interestingly, all interviewed clients (engaged or dropped out) reported that they usually ask family or close friends for help with their mental health problems.

Therapy Drop-Out Clients: Most clients who did not engage reported elevated levels of social isolation; most clients reported that they only have a few friends, others reported being far away from their families and in sporadic contact with them. Some clients (2 from Black, 1 from White ethnic backgrounds) also reported that their friends or relatives would have a negative opinion of someone who is in contact with psychology (e.g. *"They'd think you're barking mad"*, *"...you're barmy"*, *"...you've got to be mad"*). The other clients in the "*drop-out*" group refused to answer this question.

Engaged Clients: In contrast, the majority of the clients who engaged with psychology reported that their social support groups have either positive opinions about seeing a psychologist (e.g. *"It's like going to the GP, it's great if you can see a psychologist"*) or simply said that they are not discussing their therapy with their social support network outside the service.

5. Conclusions

The findings indicate that there are differences in referral rates and the take up of therapy according to ethnicity. Although Black and Ethnic minorities make up 30% of Lambeth's population, 48% of clients referred to psychology were from Black backgrounds. The referral and uptake patterns suggest that access to psychological therapy for service users from Black backgrounds is fair and there is no discrimination based on ethnicity in term of initial service delivery.

Although it is not possible to draw definitive conclusions from the results presented here, given the small numbers in some data categories, the results indicate that there may be some discrepancy in terms of referral and engagement with psychological therapy for some service users from a Black background. This finding is in line with previous research showing a high incidence of psychosis in BME groups.

The fact that only 61% of service users from a Black background offered psychological therapy engaged in it, compared with 77% of White clients should be interpreted with caution. A previous audit conducted in Croydon (McGourty, 2011) found that 14% fewer black clients completed therapy than White clients. The present study suggested that 19% fewer Black clients were engaged with psychology at the time of the audit. Thus, on one hand, these results support McGourty's findings, suggesting that service users from a Black background are more likely to drop out of therapy. On the other hand, there were considerably more referrals and uptake of clients from Black backgrounds than White or other backgrounds. That made it comparatively more likely to encounter drop outs from this group rather than the other two (White and other backgrounds) which were under-represented in this sample. For example, the same case can be made by comparing clients from a White background with clients from Asian, mixed Asian background, Middle Eastern, etc. (collapsed under "other" category). 86% of these clients engaged in psychology, which is markedly better than 77% White clients. However, there were only 7 clients in this group in comparison to almost double (13 clients) in the White ethnic group. It is also worth noting that the drop out rates for clients from a Black ethnic background presented here (29%) are lower than previously reported in some published studies (e.g. 48% Sparks, Daniels & Johnson, 2003). These lower drop out rates may be a direct consequence of SHARP's recovery oriented approach to managing mental health. Within the wider service, psychology aims to support the clients by helping them to build and maintain a self-determined, meaningful and satisfying life, regardless of whether or not they still experience symptoms of mental illness. However, due to the small sample size it is difficult to draw any definitive conclusions.

Although the data are limited and the conclusions should be interpreted with caution, it the findings from this audit suggest that once psychological therapy is offered, discrepancies in terms of experience start to emerge. One potential hypothesis explored in this study was that a client's motivation to engage may have been linked in some way to the insight into their condition as well as their understanding of psychological services. The finding that all clients who engaged with psychology, regardless of their ethnic background were able to discuss their referral in more detail and had more insight into their condition is an interesting finding. If the experience of psychological assessment and the explanation of therapy did not fit with the perceived needs of some service users from BME ethnic backgrounds it might explain the higher rate of therapy being abandoned. However, it is unclear whether this greater understanding came as a result of their engagement or was there prior to starting psychological therapy and facilitated engagement. It is also possible that clients who did not engage had a similar understanding of their referral, but were reluctant to discuss it over the telephone with someone they had never met. Further studies could address this limitation by enlisting the help of the client's therapist in collecting these data.

Previous research has suggested that psychological therapy can be successfully adapted to ethnic minorities and it has a beneficial effects not only on clinical outcomes but also on client satisfaction and engagement (e.g. Rathod, Kingdon, Phiri and Gobbi &, 2010; Rathod et. al., 2013). Presumably adapting assessment and psychoeducation in a similar way could also have beneficial effects in terms of instilling hope and motivating clients to engage in subsequent sessions. At this stage it is unclear what information about psychological services clients found particularly difficult to understand. Therefore more data needs to be gathered about clients' preconceived ideas regarding psychological therapies before an intervention can be devised. This could be done via qualitative methods (e.g. focus groups may be particularly beneficial as they may stimulate discussions and enable clients with cognitive difficulties to express and elaborate in their ideas) or quantitative (e.g. purpose built questionnaires).

Another aim of our study was to investigate the possible reasons for clients abandoning therapy at a later stage. Our data suggests that unforeseen events in the clients' lives, such as bereavement, separation, issues regarding immigration status may have overwhelmed them and some of them decided to dedicate their limited resources to dealing with these problems rather than to attend therapy. Most of the clients reporting these problems were from Black ethnic backgrounds, but not exclusively. This finding is in line with previous suggestions in the literature (e.g. social defeat hypothesis, Selten & Cantor-Graae, 2005; Selten et al., 2013). It is also possible that some of the clients (especially the ones who dropped out) felt these problems could not be addressed in therapy, or may be beside the point of therapy (which was aimed mainly at managing psychotic symptoms).

Interestingly, it also emerged that clients who expressed doubts about their cognitive abilities (which they perceived as inadequate for psychological therapy) were more likely to drop out. Although the clients who expressed this view were from a Black ethnic background, given the small sample size it cannot be concluded that these clients were systematically dropping out because they doubted their cognitive abilities. However, this is an important point to be further investigated in future studies, since previous research reported low self esteem in BME populations (e.g. Selten and Cantor-Graae, 2005). It is unclear whether the clients who engaged were more confident in their cognitive abilities, or simply they realised their abilities were adequate after experiencing a few sessions of psychological therapy. Importantly, all of the interviewed clients (drop out and engaged groups) reported that their spiritual or cultural beliefs were adequately attended to, which seem to suggest that their doubts about psychology are not culturally related (although we suspect some preconceived negative beliefs about psychology might have been influenced by the wider culture, perhaps through media).

Finally, our data has shown important differences in the impact of the clients' social support network. In line with previous research (e.g. Selten and Cantor-Graae, 2005; Reininghaus et. al., 2010, Selten, et al., 2013), our data has

shown that clients who dropped out report higher rates of social isolation. However even clients who reported having stable and reliable social group, but whose members held negative beliefs about mental health services, showed higher dropped out rates than clients whose social support network was highly supportive of their engagement with the services. Thus the service should be aware of the fact that social support networks may need to be brought on board with the scope and methods our services in order to help them develop protective views (e.g. support for attendance, social inclusion, hope).

Although we aimed to identify the factors that may affect engagement or disengagement differentially across ethnic groups, it is important to note that most factors discussed above impacted clients from all cultural backgrounds. This suggests that any interventions to increase engagement would be beneficial across all ethnic groups. While some previous research has shown marked differences in engagement across ethnic groups, this research has demonstrated similar reasons for disengagement across all client groups. However, it must be acknowledged that our sample size is relatively small and therefore these results should be interpreted with caution.

6. Limitations

In addition to limitations described so far it is important to state that this audit did not investigate the views of clients who did not accept the offer of therapy. Their views may add valuable information to why some clients do not engage with psychology. Also it is not clear what role language preferences and ability play between clients who engage and complete therapy compared with those who decline therapy or drop out. Is this a perceived level of ability (similar to the general point of cognitive abilities discussed above) of an actual level of ability that is seen as an obstacle?

Similarly, our drop out rates are calculated by ethnicity and gender, but they do not take into account overall levels of deprivation. This is an important

uncontrolled variable (in our study) which may explain why some clients from a BME background' engaged whereas others did not. In other words, is disengagement simply determined by ethnicity or are we dealing with a far more complex picture where overall levels of deprivation are affecting engagement in psychological therapy. This would be congruent with previous research such as the "social defeat hypothesis" (e.g. Selten et al. 2007). It is likely that this complex picture also includes factors such as: perceived language and cognitive abilities, preconceived ideas and concepts about psychological therapy, social factors, stigma about mental health conditions, cultural factors, band probably many more (as suggested by Cantor-Graae, 2007).

There are a number of other factors that were not taken into account during this audit, as data was unavailable, such as therapist variables (age, gender, ethnicity and experience), length of wait between initial referral and starting therapy, and distance between clients' homes and treatment centre. It is unclear whether these factors had impact on engagement and drop-out rates and more importantly, if they had, what was their relative impact on engagement in comparison to the factors identified in this study.

7. Recommendations

- Finding out more about the client's preconceived ideas about psychology.
- In the light of previous point create psychoeducation materials that the clients can take home and study at their leisure. This should also attempt to dispel some of the myths about psychological therapy (such as how "smart" someone needs to be in order to benefit from therapy)
- Offer social inclusion therapy to clients from Black ethnic backgrounds who are socially isolated as this may act as protective factor for engagement.
- Collect more data regarding engagement for more effective auditing.

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9. Appendix I: Audit & service evaluation project proposal form

Appendix 4: Project Proposal Form (PPF) for Clinical Audit, Service Evaluation and other Quality Improvement Projects

Should you require any assistance with completing this proforma, please contact your Local Clinical Audit Project Officer or, for Trustwide audits, the Clinical Audit & Effectiveness Team (details are available on the SLaM Clinical Audit & Effectiveness Internet Site). For local team-based or CAG-wide projects please send your completed PPF to your local Audit Project Manager/Officer, for ethical approval. For Trustwide projects please send your completed PPF to the Corporate Audit Dept. All relevant contact details are on the SLaM Clinical Audit & Effectiveness Team Intranet site.

1(a) Project lead details:	
Name: Dr. Matei Vladeanu	**Job title: Clinical Psychologist in Training**
Work Address: SHARP, 308-312 Brixton Road, London, SW9 6AA	
Telephone: 07872160262	**E-mail: matei.vladeanu@slam.nhs.uk**
1(b) Project Title: A review of demographic differences in engagement with Psychology services at SHARP (Social Inclusion, Hope and Recovery Project).	
Project start date: August2013	**Project end date: December 2013**

1(c) Please tick ✓ one box: Is this project a:		
Clinical Audit ☐ **(i.e. measures a standard)**	**Service Evaluation** ☒ **(e.g. patient survey)**	**Other Quality Improvement Project** ☐ **(please specify)** _____

1(d) Which CQC Standards does this audit relate to: Please tick ✓ relevant boxes:	
Involvement and Information ☒	Personalised Care, Treatment and Support ☒
Safeguarding and Safety ☐	Suitability of Staffing ☐
Quality Management ☐	Suitability of Management ☐

2 (a) Overall project aim or purpose of the audit

This project aims to evaluate access to and drop-outs from psychological therapies across different ethnic groups. In particular we wish to look at whether there are differences in engagement and drop-out rates in people from Black and Minority Ethnic (BME) groups, and explore the possible reasons for these differences in order to inform potential improvements.

The specific aims of the project are to evaluate:

a) proportions of referrals to therapies within the SHARP service (psychosis CAG), according to ethnic group;

b) the distribution of non-engagement and dropouts from therapies within the SHARP service, based primarily on ethnicity and gender;

c) the possible reasons for non-engagement and drop-out from psychological therapy, in comparison to other treatments on offer at the team, particularly in service users from BME groups.

2(b) Specific objectives. What are the audit standards or criteria?

The definition of a clinical audit is that it compares practice to agreed standards such as those defined in NICE guidelines and clinical policies, protocols and procedures. Please also state the source of your standards or criteria (for non-audit projects, clarify and contextualise aim).

The NICE guidelines for Schizophrenia (2009) highlight the importance of monitoring and reviewing 'access to engagement with psychological interventions', including 'equality of access across different ethnic groups'.

This project aims to monitor and review referrals and engagement/drop-out rates for service users referred to the SHARP service (psychosis CAG) for psychological therapy, according to ethnicity. Where there is non-engagement or drop-outs we wish to look at the possible reasons for this, particularly in BME groups in order to inform future developments to help to ensure 'equality of access'.

2 (c) Does the project relate to an area of Trust Policy? Please check the Policy site on SLaM Intranet.

Yes ☐ No ☒

If Yes, please state which policy_____

2 (d) If the project relates to an area of Trust policy, please confirm that the standards and criteria in the clinical audit have been drawn from standards within the Trust policy?

Yes ☐ No ☐

Comments: __N/A_____

2 (e) Have you submitted your proposed audit data collection tool or questionnaire along with this Project Proposal for approval?

Yes ☒ No ☐

Comments: _____

2 (f) Does the data collection tool or questionnaire clearly and accurately monitor the standards outlined above?

Yes ☒ No ☐

Comments: _____

2 (g) In which ways do you think the project will improve patient care / outcomes?

We aim to use the quantitative data to evaluate the numbers of recent referrals to therapies at the SHARP team, in terms of ethnicity, and particularly in terms of engagement and drop-out rates from psychological therapies to establish whether there is any difference in rates according to ethnicity. For the second part of the evaluation, we wish to interview a number of clients, particularly from BME backgrounds, who have disengaged with psychological therapy (but may have continued to engage with other interventions on offer at SHARP). The interview will aim to gather information on potential reasons for drop-out, particularly those which might be specific to cultural or spiritual needs, with the purpose of informing recommendations towards improving engagement with psychology in particular**.**

3 (a) Type of project Please Tick ✓ where appropriate – more than one might apply

(A) National	☐	Re-audit	☐	High risk	☐
(B) Trust-wide	☐	Across primary/secondary interface	☐	High volume	☐
(C) Directorate/CAG	☐	Multidisciplinary	☐	Issue of local concern	☒

(D) Team based	☒	Uni-disciplinary	☒	Wide variation in practice	☐
Other (please state):					

3 (b) Does your project criteria apply to any of the following? If so Please Tick ✓ where appropriate

NHS Litigation Authority (NHSLA)	☐	Risk Register (high risk)	☐	Complaints	☐
Trust Policy	☐	CQC	☐	Patient Survey	☒
NICE Guidance	☒	Business Plan	☐	DOH Policy Implementation Guidance	☐
National Audit	☐	Improving working lives	☐	Issue of local concern	☐
Any Other (please state)					

4(a) Who will be on the audit steering group?

Matei Vladeanu, Helen Waller, Tom Ward, Adrian Webster

4(b) What consideration has been given to the involvement of patients, carers or the public?

☐ Full user involvement at all stages of the audit

☒ Partial user involvement : please state what stages __Data Collection_____

☐ No user involvement (please state why not) _____

5. Information Governance Requirements: When planning an audit, each project should be evaluated with regard to whether **Personal Identifiable Information(PII)** needs to be used. Unless there is genuine justification, all PII should be taken out to effectively anonymise the data for audit and research purposes. If you are unsure or need guidance and advice, please contact: dataprotectionoffice@slam.nhs.uk

Personal identifiable information (PII) is any piece of information which can potentially be used to uniquely identify, contact, or locate an individual including name, address, full post code, date of birth, gender, ethnicity, NHS number, photographs, videos, audio-tapes etc.

<table>
<tr><td>5(a) Source of data</td><td colspan="3">☒ Patient ☐Other (please specify)
☒ Staff</td></tr>
<tr><td>5(b) Method of collection</td><td>☒ Direct from subjects (interview or questionnaire)</td><td>☒ From an information system (e.g. ePJS)</td><td>☒ Other (please specify)
SHARP team referrals database</td></tr>
<tr><td rowspan="4">5(c) Will the data be fully anonymised?</td><td>☒ Yes</td><td colspan="2">☐ No</td></tr>
<tr><td rowspan="3">If yes, how: No personal identifiers will be used.</td><td colspan="2">If no, why not:</td></tr>
<tr><td colspan="2">If no, which personal identifiers will be used</td></tr>
<tr><td colspan="2">If no, have you made arrangements to gain consent from data subjects?
☐ Yes ☐ No</td></tr>
<tr><td>5(d) Where will the data be recorded?</td><td colspan="3">☒ Manual forms ☐ Other (please specify)
☐ Electronic forms
☒ Electronic spreadsheet</td></tr>
</table>

	☐ Electronic database
5(e) Where will it be stored?	☒ In a locked cabinet ☐ Other (please specify) ☐ In a locked office ☒ On shared folder on SLaM network ☐ On secure network outside SLaM
5(f) Additional security arrangements	☒ Password protected ☐ Other (please specify) ☒ Encrypted ☐ Login required
5(g) Will the data be transferred outside SLaM	☐ Yes, in an anonymised format ☒ No ☐ Yes, with identifiers **You must contact dataprotectionoffice@slam.nhs.uk to register any transfer of personal identifiable information in advance.**
	If yes, how ☐ Physically in person ☐ Physically using a secure courier ☐ Physically using registered mail services ☐ Electronically using nhs.net e-mail ☐ Electronically using encrypted portable media ☐ Other (please specify)
5(h) Will the data leave the EU?	☐ Yes (Please specify where and why) ☒ No

5(i) Information Asset Owner: This is the person responsible for the data	Name:	Dr. Matei Vladeanu
	Job title:	Clinical Psychologist in Training
	CAG:	Psychosis CAG
	Organisation:	SLaM

6) Data Collection (please answer ALL of the following questions)	
6(a) Where from? Audit data can be collected from many sources including: medical records/ePJS, nursing records, patients, clinicians, and other staff.	**SHARP referrals database; ePJS; directly from patient interviews.**
6(b) How? The data source will obviously influence the method used to collect data. E.g. If data is to be collected from patients the most appropriate method might be a survey or interview. If data is to be collected from medical records, it will be necessary to design a data collection proforma. Questionnaires, one-to-one interview, focus groups.	**Data will be gathered from all SHARP referrals over the past 1 year.** **Clients from BME backgrounds will be invited to take part in a short interview survey, by letter or through other health professionals they are currently working with. A semi-structured interview will be carried out (see questions and prompts attached).**
6 (c) How much? As a guide, a sample should include a minimum of 30 cases and perhaps as many as 100. If the initial sample proves to be too small to provide data necessary, it can be added later.	**For the first part of the evaluation all referrals to the team over the last year will be included (approximately 200). For the interviews, we hope to speak with approximately 20 clients, mostly from BME backgrounds.**

6 (d) Who? Who will be responsible for collecting the data? Ensure the person identified understands their role.	**Dr. MateiVladeanu, Clinical Psychologist in Training.**
6(e) Timescale? Over what period is the data to be collected?	**August – December 2013.**
6 (f) Pilot Audit? Y/N In most cases it will be advisable to carry out a pilot to check quality of questionnaire, length of interview, etc. In light of the pilot audit findings, modifications to any of the above may need to be made.	**Yes.**
7(a) Who will be affected by the outcomes of this project? **The SHARP Service, where the audit is being carried out (Psychology in particular). However, the outcomes and recommendations are likely to apply to psychology services in general across SLaM.**	
7(b) With whom and where will the final report be shared? i.e. Local Clinical Governance Committees, CAEC? **SHARP Team; Access to Psychological Therapies in Psychosis (ATPT) committee.**	
7(c) Who will take responsibility for disseminating the results of the project and following through recommendations and actions? And how and when will the recommendations and actions be evaluated, monitored and reviewed? **MateiVladeanu will be responsible for the write up of the project, including presentation of the results and recommendations at a team meeting and at the larger APTP committee meeting.**	
All completed projects must be followed up with a completed audit recommendations monitoring form, available on the SLaM Clinical Audit & Effectiveness Intranet site http://sites.intranet.slam.nhs.uk/cg/default.aspx	

8) Project Approval	
8(a) Information Governance Approval: IG Audit approval given by: _____ Date Audit IG approved:_____	**8(b) Project Ethical approval given by:** Clinical Audit Ethical approval given by: _____ Date of Clinical Audit Committee approval:_____ ☐ Quality Governance Committee ☐ Drugs and Therapeutics Committee ☐ CAG Clinical Governance/Audit Committee

10. Appendix II: Structured Interview

Interview Script/Data Collection Sheet

Patient: _____

Date:_____/____/____

Hello, my name is Matei Vladeanu, and I'm a Trainee Clinical Psychologist. I'm calling from the SHARP team where you've been seen a while ago. We're trying to get feedback from people who have used the service, to hopefully lead to improvements in the future. I was wondering if you'd be ok chatting for a few minutes with me about your experience there. Is this ok?

If no:

- is this not a good time? Would you like me to call later? **Apptx:**

If yes:

Thanks, that's great! I am calling you because we are trying to improve our service and we're really interested to hear how you found our service. There are no right or wrong answers, and everything we talk today is confidential. I'm independent from the team, so you can be as open and honest with me as you like. Your information is also anonymous. So, I'd really like to hear your opinions. Is that ok?

Data:

We're particularly interested in people's experiences of psychological therapy. I understand you were originally referred to SHARP for psychological therapy.

1. **What was your understanding of your referral for psychological therapy at SHARP? Why do you think you were referred?**

A:_____

_____

2. **Were you able to attend any sessions?**

    a. **Yes:** How many?

    A:_____

    b. **No:** Could you tell me about why?

    _____

    _____

    _____

3. **How did you find the initial sessions?**

    Prompt: What were the best and worst aspects?

    A:_____

    _____

    _____

4. **We're interested in finding out more about the types of things that made it hard for you to attend.**

    Did you have any concerns?

    A: _____

    Were there any other things going on in your life at the time?

    A: _____

    Was it anything to do with the service?

    A: _____

    Did you have previous experience with psychology?

A: _____

Did the sessions seem to fit with your cultural or spiritual needs?

A: _____

Did you feel your background and culture were adequately attended to?

A: _____

Did you feel your spiritual needs were taken seriously?

A: _____

5. **What do your friends or relatives think about someone seeing a psychologist?**

   A:_____

   _____

6. **Do you think something else would have been better suited for your needs?**

   A:_____

   _____

7. **Was there anything else you were involved at SHARP?**

   A:_____

   _____

8. **Where would you usually go for help?**

   A:_____

   _____

   Prompt: Is anything different about [other therapy] which has meant that you have found it easier to continue?

   A: _____